Dissertation On

FUNCTIONAL OUTCOME OF INTERTROCHANTERIC FRACTURES TREATED BY PROXIMAL FEMORAL NAILING ANTI-ROTATION-II

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M.S. Degree

(Branch – II – Orthopaedic Surgery)

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DEPARTMENT OF ORTHOPAEDICS

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CHENNAI

CERTIFICATE

This is to certify that the dissertation entitled ***“Functional outcome of Intertrochanteric fractures treated by Proximal Femoral Nailing Anti-rotation-II”*** is a bonafide record of work done by **Dr.G.VINOTH KUMAR** in the Department of Orthopaedics, Kilpauk Medical College, Chennai.

Prof. S. SENTHIL KUMAR, M. S. Orth., D. Orth.,

Professor and HOD,

Department of Orthopaedics,

Govt. Royapettah Hospital,

(Govt. Kilpauk Medical College)

Chennai- 600014

Prof. P. VASANTHAMANI M.D, DGO., MNAMS, DCPSY, MBA

The Dean,

Govt. Kilpauk Medical College,

Chennai- 600010

ETHICAL COMMITTEE CERTIFICATE

INSTITUTIONAL ETHICS COMMITTEE
GOVT. KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Protocol ID. No. 79/2018 Meeting held on 12.03.2018

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "FUNCTIONAL OUTCOME OF INTERTROCHANTERIC FRACTURES TREATED BY PROXIMAL FEMORAL NAILING ANTI – ROTATION – II " Submitted by Dr.G.Vinoth Kumar, Post Graduate M.S., Ortho., Govt. Royapettah Hospital / Kilpauk Medical College, Chennai.

The Proposal is **APPROVED.**

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

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ME 1 Sec> Ethical Committee

DECLARATION

I **Dr. G. VINOTH KUMAR**, solemnly declare that the dissertation entitled "Functional outcome of Intertrochanteric fractures treated by Proximal Femoral Nailing Anti-rotation-II" has been prepared by me under the able guidance and supervision of my guide **Prof. S. SENTHIL KUMAR, M.S.Ortho., D.Ortho., Prof & HOD**, Department of Orthopaedics and Traumatology, Kilpauk medical college, Chennai, in partial fulfilment of the regulation for the award of **M.S. (ORTHOPAEDIC SURGERY)** degree examination of the Tamilnadu Dr. M.G.R. Medical University, Chennai to be held in March 2018. This work has not formed the basis for the award of any other degree or diploma to me previously from any other university.

Place : Chennai

Date :   **Dr.G.VINOTH KUMAR**

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VINOTH KUMAR (drvinothkumarg)

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INTRODUCTION Intertrochanteric fracture is one of the most devastating injuries in the elderly. The incidence of these .fractures increases with advancing age[1] . These patients are more limited to home ambulation and are dependent in basic and instrumental activities of daily living. 50 % of fracture around hip patients in elderly is of trochanteric fracture and these 50 % of fracture are unstable type of trochanteric fractures. They are usually complicated with associated co-morbidities like .osteoporosis, diabetes, hypertension, renal failure. In such circumstances, non-operative treatment is mainly reserved for poor medical candidates and non-ambulant patients with minimal discomfort after fracture. Today operative treatment has largely replaced conservative measures and the goal of treatment is to achieve accurate or acceptable. anatomical and stable reduction with rigid internal fixation .in order to achieve early mobilization of patients and prevent complications of prolonged recumbence. Despite marked improvements in implant design, surgical technique and patient care, intertrochanteric fractures continue to consume a substantial proportion of our health care resources and remain a challenge to date[2]. Complications with intertrochanteric fractures arise primarily from fixation rather than union or delayed union. because the intertrochanteric area is made up of cancellous bones[3].

The strength of the fracture fragment-implant assembly depends upon various factors including (kueffer et.al). [4] . (a) Bone quality, (b) Fragment geometry, (c) Reduction, (d) Implant design and (e) Implant placement. Among all these factors, surgeon can only control the quality of the reduction, choice of implant and its placement . There is a wide variety of treatment options for these fractures .The sliding hip screw device has been used for more than a decade for the treatment of these fractures which may not be an ideal implant in all cases[5][6]. Intramedullary load sharing device - PFN helps in early post operative mobilization ,weight bearing

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There is a wide variety of treatment options for these fractures. The sliding hip screw device has been used for more than a decade for the treatment of these fractures which may not be an ideal implant in all cases[5][6]. Intramedullary load sharing device - PFN helps in early post operative mobilization, weight bearing and ultimately the early fracture union. PFNA-II utilizes a helical blade instead of the conventionally used two screws. The helical blade is believed to provide stability, compression as well as rotational control of the fracture. Theoretically it compacts the bone during insertion into the neck and hence has higher cut out strength as compared to other devices. The differences are that mediolateral angle is reduced from 6 degrees to 5 degrees. Hence there is less chance of implant failure especially in elderly, osteoporotic bones. Thus, PFN Anti-rotation-II is a modification of the conventional PFN which reduces even the minimal complications associated with Conventional PFN , also providing additional advantages .

AIM OF STUDY

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To Assess Functional outcome of Intertrochanteric fractures treated by Proximal Femoral Nailing Anti-rotation-II

REVIEW OF LITRATURE

REVIEW OF LITERATURE

Although fractures of hip were known since time of Hippocrates, **Sir Astley Cooper** (1822) [6] was the first to have given the accurate description of fracture occurring at proximal femur and who has distinguished extra capsular from intra capsular fractures many decades before the discovery of x-rays.

Percival Pott [7] at the end of 18th century was the first to stress the need of exerting traction in fractures of upper end of femur.

Steinmann[8] in 1907 devised the metallic traction which proved to be more effective way of applying traction. Invention of tri-flanged nail for internal fixation of fractures of femur by **Smith Peterson[9]** (1925) was the major breakthrough in field of internal fixation device for trochanteric fractures.

Thornton (1937) [10] added an adjustable side plate to the S.P nail and thus made it possible to use it for fractures of trochanter.

Boyd and Griffin[11] (1949), **Fielding and Magliato** [12] (1966), **Zickel [13]**(1976), suggested surgical management for pertrochanteric and subtochanteric fracture. **Mervyn Evans [14]** (1951) classified fractures into stable and unstable group thus putting emphasis on stability of the fracture which is very important for deciding line of management and improving the ultimate outcome.

Raymond and Tronzo [15]described new classification of fracture, classifying it into 5 different types keeping in mind the anatomy of fracture which is becoming more acceptable internationally at present **Jewett** [16] (1952) recommended that all hip fractures be treated with 135 degree nail plate device. He also developed the fixed angled nail plate which was initially biflanged and later on changed to triflanged. As they do not allow controlled collapse and impaction at the fracture site, without penetration of the femoral head, a stable reduction (anatomical or non anatomical) period to nail insertion is essential.

Taylor G.M.[17] (1955) was the first to talk of various deformities resulting from fractures. He stated that varus deformity is symptomatic when the neck shaft angle is less than 120 degrees. **Clawson DK [18]** in 1959 with help of Richards manufacturing company invented the sliding compression screw device which is the second major breakthrough in the field of internal fixation devices for fractures

Saramiento[19] (1963) introduced the technique of valgus osteotomy to obtain stability in unstable fractures.

Dimon and Hugston [20] (1964) have suggested an easier way of achieving stability, the medial displacement technique. **Weismann et.al** (1964) [21]were fixing the lesser trochanter in order to achieve anatomical reduction while **Wardie** [22] (1967) has stated that reduction and fixation of displaced lesser trochanter fragment to femoral shaft in order to provide a stable buttress for reduction to proximal fragment is difficult time consuming and often unsuccessful.

Fielding and Magliato (1966) [12] proposed a simple classification in which they have defined subtrochanteric fracture. **Singh**[23] (1970) introduced the method of examining the degree of osteoporosis by x-ray evaluation of trabecular pattern of proximal femur. This is important as fixation of proximal fragment and fracture stability depends on bone quality.

Ender[24] (1970) introduced multiple flexible Condylocephalic nails. **Harrington** (1975) [25] recommended use of methyl methacrylate cement to reinforce the internal fixation in osteoporotic bone. It does improve the fixation, but is associated with increased incidence of infection and delayed implant loosening.

Seinsheimer[26] (1978) presented a new classification for subtrochanteric fractures. **Green et al** (1986) and **Stern et al** (1987) [27] have presented a series of comminuted fractures treated with Leinbach prosthesis and concluded that it is recommended for the elderly patients with comminuted fractures.

In 1959, AO blade plates were developed by ASIF. They advised the device to be effective, must function as tension band, with presence of prompt reconstitution of an intact medial cortical buttress.

Russel Taylor[17] (1990) introduced reconstructed intramedullary nail for pertrochanteric and subtrochanteric fractures **RJ Medoff**[28] in 1990 designed a device that allows axial compression through the neck portion and through the metaphyseal subtrochanteric portion through a sliding device that is incorporated onto the plate attachment to the shaft of femur. The compression slide acts as a intermediate segment, capturing the lag screw proximally and .engaging the barreled side plate distally in a sliding track. The barreled side plate is attached to the femoral shaft with the bone screws directed into two planes. This is called “The axial compression screw plate device”. **Halder and Williams**[29] in 1992 introduced Gamma Nail and Parker described complications of Gamma nail**. S.C. Halder** in 1992 published paper on the Gamma nail for peritrochanteric fractures.

In 1994, **Gargan M F, Gundle R, Simpson A** claimed that there is no benefit of osteotomy and therefore recommended anatomical reduction and fixation by the sliding hip screw in most cases.

After invention of so much implants in history as mentioned above, studies based on comparison to prove the best one started evolving.

In 1994, **Blatter et al** [31] studied about treatment of the pertrochanteric and subtrochanteric fractures of the femur with DCS. In 1994 an author studied about pertrochanteric and subtrochanteric fractures of the femur treated with Zickel nail. Zickel nail is not been recommended by them any more for treatment of pertrochanteric and subtrochanteric fractures**. Butt M.S. Krikler S J, Nafie, Ali** [32] studied the comparisons of Gamma Nail and DHS and found that clinical and radiological union results with both implants were the same but the rate of complication with Gamma Nail was higher .In 1995, **M R Baumgaertner, S L Curtin, D M Lindskog** and **J M Keggi**[33] had developed a simple method to describe the position of the lag screw. In this the tip apex distance (TAD) In their study, to determine the value of this measurement in prediction of the so called cut out of the lag screw the average tip apex distance is 24 mm for .successfully treated fractures.

In 1996, the AO/ASIF developed the proximal femoral nail (PFN) as an intramedullary device for the treatment of unstable per-, intra- and subtrochanteric femoral fractures in order to overcome the deficiencies of the extramedullary fixation of these fractures. This nail has the following advantages compared to extramedullary implant-such as decreasing the moment arm, can be inserted by closed technique, which retains the fracture hematoma an important consideration. in fracture healing, decreases blood loss, infection, minimizes the soft tissue dissection and wound complications.

Gotze et al[34] compared the loadability of osteosynthesis of unstable per-and subtrochanteric fractures and found that the PFN could bear the highest loads of all devices.

PFN A (antirotation) was introduced in 2003 with modifications, helical blade. In 2008 PFNA2 was introduced mainly to avoid lateral cortex impingement during nail insertion which was a common problem in asian population due to shorter and narrower greater trochanter.

- ***Mediolateral angle from 6 deg to 5 deg***
- ***Flat lateral surface***
- ***Proximal nail diameter reduced from 17 to 16.5mm***

These changes avoided intra-operative fractures, post-operative hip pain, allowed easier insertion, specifically for Asian population.

In 2012 **Soucanye de landevoisin and E.Demortiere** [35] study showed PFNA was best in treating intertrochanteric fractures.

History, having shown the improvements in treatment of trochanteric fractures from non-operative management to operative techniques, the implants for operative techniques have been modernized based on the pros and cons of each implant being designed. Thus currently used intramedullary implants have been designed with combination of advantages of nails and compression devices/ sliding screws. The PFN A-II is also such a device designed to address the Asian population after learning so much from the previous devices.

TREATMENT OPTIONS

Nonoperative treatment: Before the introduction of suitable fixation devices in the 1960s, treatment for intertrochanteric fractures was mainly of nonoperative, consisting of prolonged bed rest in traction until fracture healing occurred (usually 12 weeks) followed by a lengthy programme of ambulatory training. In elderly patients this approach was associated with high complication rates. Typical problems like decubitus ulcer, urinary tract infection, joint contractures, pneumonia and thromboembolic complications occurred. In addition fracture healing was accompanied by varus and external rotation deformity and a .shortened extremity because of the inability of traction in effectively counteracting the deforming muscular forces.

Indications of nonoperative treatment:

1. An elderly patient whose medical condition carries an excessively high risk of mortality from anaesthesia and surgery.
2. Non ambulatory patient who has minimal discomfort following fracture.

Historically nonoperative management took one of the 2 different approaches. In first approach directed at **early mobilization** within the limits of patients discomfort the patient was allowed out of bed and in a chair within a few days of injury. Ambulation was delayed but the early bed to chair mobilization helped to prevent many of the complications of prolonged recumbency. A second approach in contrast attempted to establish and maintain a reasonable reduction via **skeletal traction**. The period of traction using this technique was prolonged and an acceptable position was difficult to achieve and maintain. Nursing care was also exceedingly difficult resulting in all the complications noted previously. When nonoperative management is required in the elderly usually the first approach is preferred.

Techniques of operative fixation have changed dramatically since the 1960s and the problems with early fixation devices have largely been overcome. Operative management consisting of fracture reduction and stabilization that permits early patient mobilization and minimizes many of the complications of prolonged bed rest, have consequently become the treatment of choice for intertrochanteric fractures even in complicated patients.

OPERATIVE TREATMENT

Evolution of surgical techniques Plate and screw devices:

Successful earlier implants were fixed angle-nail plate devices, eg Jewett nail, Holt Nail consisting of a triflanged nail fixed to a plate at an angle of 130 to 150 degrees. They provided stabilization of the femoral head and neck fragment to the femoral shaft, but they did not affect fracture impaction. If significant impaction of the fracture site occurred the implant would either penetrate into the hip joint or cut out through the superior portion of the femoral head and neck. If on the other hand no impaction occurred lack of bony contact would result in either plate breakage or separation of the plate and screws from the femoral shaft. This experience with fixed angle nail plate devices indicated the need for a device that would allow controlled fracture impaction. This gave rise to sliding nail plate devices, eg. Massi Nail, Kenn Pugh Nail which consisted of a nail that provided proximal fragment fixation and a side plate that allow the nail to 'telescope" within a barrel. Impaction provided bone on bone contact, which promoted fracture union.

Figure 1 : Medoff sliding plate

The sliding nail plate devices gave rise to sliding hip screw devices. A blunt ended screw replaced the nail portion with a large outside thread diameter. Theoretically these alterations would result in improved proximal fragment fixation and decreased the risk of screw cut out by eliminating the sharp edges found on triflanged nails. To accomplish a bi-directional sliding the plate was modified by replacing the round screw holes with slotted screw holes (Eggers Plate). A 2-component plate device was introduced, the Medoff plate [28] in which a central vertical channel constraints an internal sliding component. The Alta expandable Dome plunger is a modified sliding hip screw designed to improve fixation .of the proximal fragment by facilitating cement intrusion into the femoral head. Cement is kept away from the plate barrel so that the devices sliding potential is maintained.

INTRAMEDULLARV DEVICES: The various intramedullary devices that are being used for unstable intertrochanteric fractures are Proximal Femoral Nail (PFN), **PFN A-**II (proximal femoral nail antiroation Asia), the Intramedullary Hip Screw (IMHS) and the Gamma Nail. These implants because of their intramedullary location are subjected to lesser bending moments than plate and screw devices.

Cephalomedullary nailing devices like the PFN, the IMHS and the Gamma nail couple a sliding hip screw with a locked intramedullary nail. These devices offer Several Advantages (Anglen jo et.al.[36])

a) An intramedullary nail because .of its location theoretically provides more efficient load transfer compared to a sliding hip screw.

b) The short lever arm of the intramedullary device can be expected to decrease the tensile strain on the implant, thereby decreasing the risk. of implant failure,

c) Because intramedullary fixation device incorporates a sliding hip screw, the advantage of controlled fracture impaction is maintained.

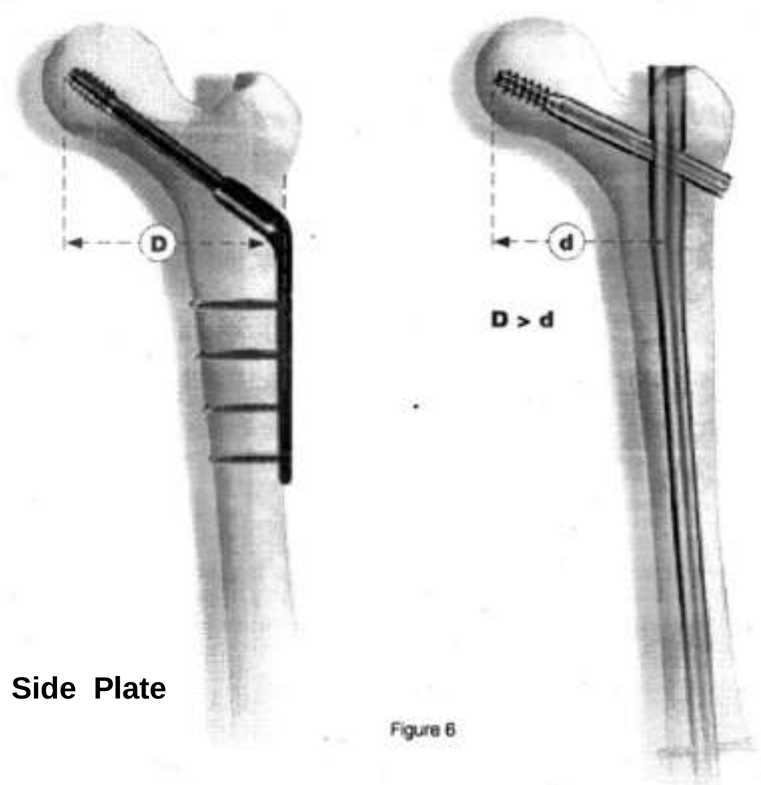


Figure 6

ADVANTAGES OF PFNA2 OVER CONVENTIONAL PFN

- Less bone loss(reaming not done)
- Increased contact surface area between. helical blade and bone of femoral head
- Rotational stability.
- Mean duration of surgery shorter
- Absence of cumbersome lag screw , derotation screw
- Mean blood loss lower
- Limited exposure to radiation
- Decreased incidence of varus and shortening
- Reduced Screw pull out
- Reduced incidence of post-op hip pain
- Absence of "Z" effect.

Reduction Techniques : Until devices became available that allowed postoperative fracture impaction, one had to achieve fracture stability at .surgery to minimize the risk of healing complications. In the absence of a stable medial .buttress the incidence of implant failure and hip joint penetration were very high. Among the methods subsequently developed to restore medial cortical continuity are medial displacement osteotomy (Dimon Hughston Osteotomy)[20], Valgus osteotomy (Sarmiento osteotomy)[19], Lateral displacement osteotomy (Wayne County Osteotomy).

A medial displacement osteotomy alters the pathologic anatomy of the unstable Fracture such that it is converted into a stable albeit non-anatomic position. The surgical technique Includes:

a) Transverse osteotomy of the proximal femoral shaft at the .level of the lesser trochanter
b) osteotomy and proximal .displacement of the greater trochanter and its attached abductor musculature
c) Medial displacement of the femoral shaft
d) Impaction of the proximal fragment. into the medullary canal of the shaft.

Limb shortening can occur to the extent. that the proximal femur is impacted to the femoral shaft. This can be at least partially. Counteracted by the valgus positioning of the proximal fragment, which in turn however may interfere with the function and position of the knee.

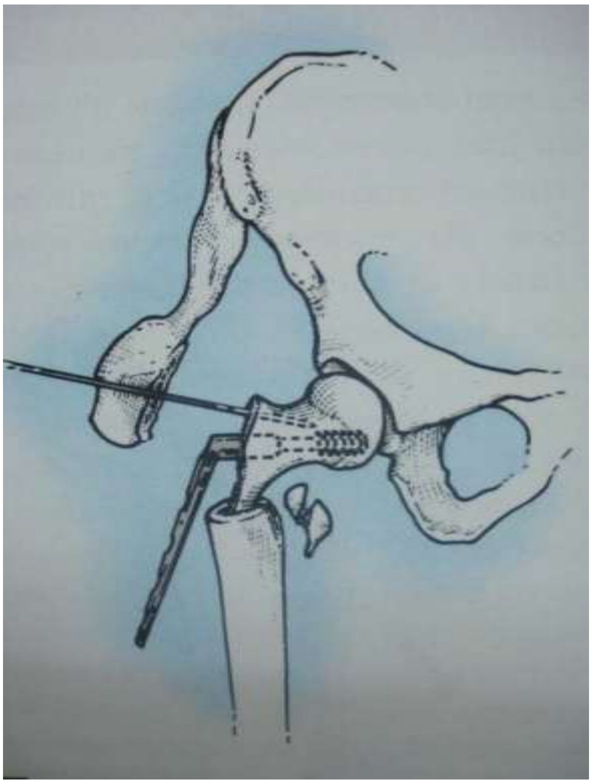


Figure 2 : Dimon Hughston medial displacement osteotomy

Sarmiento recommended a valgus osteotomy for unstable intertrochanteric

fractures to provide medial cortical buttress.

This technique involves

a. An oblique osteotomy of the proximal femoral shaft, extending from the base of the greater trochanter to a medial position 1 cm distal to the apex of the fracture,
b. Implant placement into the proximal femoral fragment, 90 degree to the fracture surface reduction and impaction of the osteotomy surfaces.

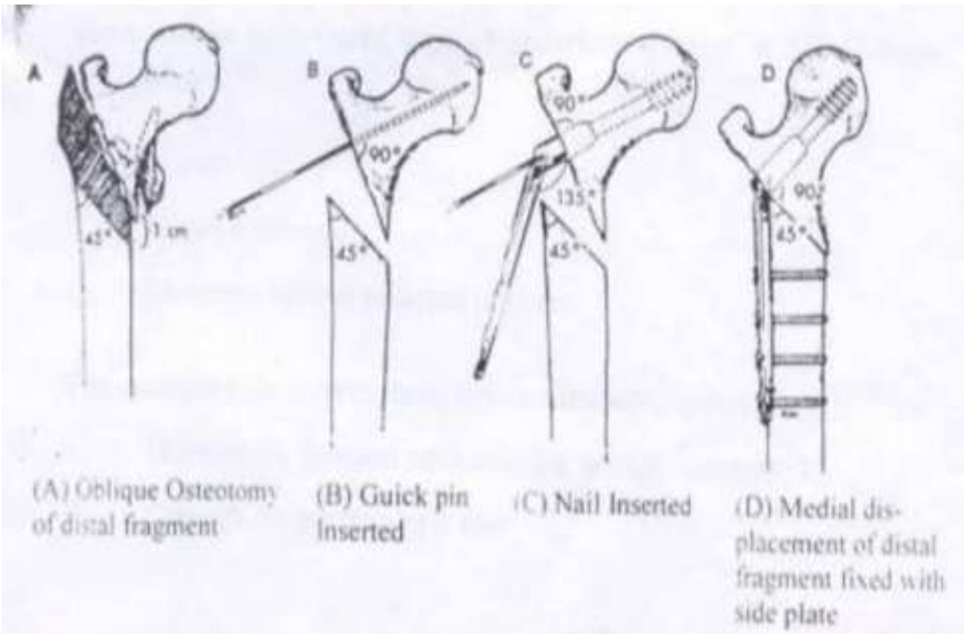


Figure 3 : Sarmiento valgus osteotomy

Wayne and County described the lateral displacement osteotomy, which involves lateral displacement of the femoral shaft to create medial cortical overlap. This technique is used for those .relatively unstable intertrochanteric fractures with small posteromedial fragment.

Since the advent of sliding hip screws there has been a renewed interest in anatomic alignment. Hopkins et al reported on a series of 55 unstable intertrochanteric fractures treated with anatomic alignment or with medial displacement osteotomy and stabilized with sliding hip screws. 89% of fractures that were anatomically aligned subsequently collapsed into a medially displaced position and 97% of the same fractures united without any complication. The author concluded that the only advantage of medial displacement osteotomy was a slightly lower rate of trochanteric bursitis secondary to less fracture impaction and screw sliding.

UNSTABLE FRACTURES

The most common unstable intertrochanteric .fractures exhibit loss of the posteromedial buttress. Another type of unstable intertrochanteric fracture is the reverse obliquity pattern, which begins just proximal to the lesser trochanter and extends laterally[14]. Follow a general approach similar to that recommended for stable fracture patterns in the preceding section: anatomic fracture alignment followed by internal fixation using a sliding hip screw. In older patients, the posteromedial fragment is usually ignored. In younger patients, an attempt should .be made to stabilize a large posteromedial fragment in a near-anatomic. position to prevent excessive screwbarrel slide, which would result in limb shortening. Furthermore, axial loading studies of unstable fractures have confirmed that reduction and fixation of the posteromedial fragment becomes progressively more important with increasing fragment size.

Reduction and stabilization of the posteromedial fragment can be performed either before or after application of the lag screw and side plate. The former method facilitates anatomic fracture reduction of the posteromedial fragment. If the main fracture fragments are reduced and. stabilized first it may be impossible to reduce the posteromedial fragment anatomically.

To mobilize and reduce the posteromedial fragment, there should be no traction on the lower extremity; since the iliopsoas is attached to the lesser trochanter traction results in proximal migration of the posteromedial fragment. The extremity is externally rotated to better expose the posteromedial area of the femoral shaft. The posteromedial fragment can be reduced using a bone hook and provisionally stabilized using a Verbrugge or standard reduction clamp. Definitive fracture fixation involves use of either one or more cerclage wires or one or more lag screws directed from anterolateral to posteromedial. These screws cannot be inserted through the proximal hole of the plate, as proper angulation cannot be achieved because of the limitations of the screw hole.

Once the posteromedial fragment is stabilized, traction is placed on the lower extremity and two main fragments reduced.

INTERTROCHANTERIC FRACTURES WITH SUBTROCHANTERIC EXTENSION

When they were first used, sliding hip screws were not. recommended for fractures extending into the subtrochanteric region, but improvements in material properties and design have broadened the Indications for these devices. Mullaji and Thomas[37], reporting on a series of 42 peritrochanteric and subtrochanteric fractures so treated, found that at an average follow-up of 11 months 91% of the surviving .patients had united satisfactorily.

When treating an intertrochanteric fracture with subtrochanteric extension using a sliding hip screw, one should reduce and provisionally stabilize the sub trochanteric component, using lag screws or cerclage wire, prior to sliding hip screw insertion. This can be accomplished on the fracture table by releasing the traction and manipulating the extremity as needed. Once the sub trochanteric component has been reduced and stabilized, traction is reapplied and the position of the femoral head and neck component checked on both AP and lateral views. Placement of the sliding hip screw then proceeds as described above. Whenever possible, screws passed through the plate should be placed as lag screws to stabilize the sub trochanteric fracture component. The distal extension of the fracture necessitates a longer plate than with a pure intertrochanteric fracture with eight to ten cortical purchase in the distal fracture fragment.

COMMINUTION AND DISPLACEMENT OF THE GREATER TROCHANTER

Because of the importance of the greater trochanter as the site of insertion for the abductor muscles, fractures that result in its comminution or displacement require special attention. If displaced, a tension-banding technique is used to reattach the greater trochanter and preserve or restore abductor tendon. With the plate stabilized to the femoral shaft, the cerclage wire is tightened to provide secure reattachment

PROSTHETIC REPLACEMENT

Primary prosthetic some replacement has had limited. use in a acute intertrochanteric fracture management. Successfully treated by internal fixation. However, elderly patients who sustain a comminuted unstable intertrochanteric fracture experience loss of reduction of fixation and require revision surgery. This population of patients would benefit most from primary prosthetic replacement. However, it is virtually impossible to identify these patients prior to surgery.

The only indications for primary prosthetic replacement after intertrochanteric fracture considered are[37]

A. Symptomatic ipsi-lateral degenerative hip disease (total hip replacement), and

B. Attempted open reduction and internal fixation. (ORIF) that cannot be performed because of extensive comminution and poor bone quality.

COMPOSITE FIXATION

Introduced by Harrington[25] for enhancing internal fixation, the use of adjunctive methylmethacrylate ("bone cement") has been advocated in patients with severe osteopenia who have sustained a comminuted, unstable intertrochanteric fracture Muhr et al emphasized that the purpose of the cement is to maintain stability of the fracture implant construct until osseous union occurs; these authors, who treated 231 intertrochanteric fractures with cement augmentation, argued that the cement provides the stability necessary for immediate weight bearing after surgery. Late complications occurred in six. patients and included non-union, screw protrusion, partial destruction of the femoral head, subcapital fracture head. All complications occurred at least 1 year after surgery and were attributed to inappropriate placement and /or excessive amounts of cement resulting in inadequate new bone formation.

Methyl methacrylate can be used to enhance lag screw fixation within the femoral head or fixation of the plate-holding screws, depending on the area of compromised fixation. When employing this technique, it is essential to obtain good fracture impaction at surgery

Soft tissues and cement intrusion into the fracture site, which could interfere with healing. The technique for methyl methacrylate enhancement of the lag screw and plate-holding screws is similar and involves screw insertion followed by screw removal, injection of liquid methyl methacrylate by syringe into the empty screw hole, and screw reinsertion. Precooling the cement monomer gives the surgeon more time for the procedure. It is interesting to note that if the screw is turned as the methyl methacrylate hardens and the screw track is then drilled and tapped, its holding power is also diminished. Therefore, the screw should be fully placed in the cement while it is still soft and tightened after the cement has set.

PATHOLOGIC FRACTURES

Operative treatment is indicated for most .pathologic intertrochanteric fractures. This treatment approach maximizes patient. function, alleviates pain, facilitates nursing care, decreases the duration and cost of hospitalisation, and improves morale. Composite fixation, consisting of a sliding hip screw supplemented with Methylmethacrylate

a. To fill the voids left by .removal of macroscopic tumour;
b. Locked intramedullary nailing; and
c. Proximal femoral replacement.

Proximal femoral replacement can be .used for those lesions that are too extensive for composite fixation. The main disadvantage of proximal femoral replacement is the mandatory need for reattachment of the hip abductors. Proximal femoral replacement with a long-stem component has the advantage, however, of providing prophylactic fixation of more distal femoral shaft lesions.

POLYTRAUMA PATIENTS

Polytrauma patients (typically young adults who have experienced high energy trauma) should undergo immediate stabilization of all long-bone fractures. Ipsilateral intertrochanteric-femoral shaft fractures occur less frequently than do concomitant femoral neck-shaft fractures. If the hip and shaft fractures are in close proximity, a sliding hip screw with a long side plate may suffice; this is by far the simplest and most effective means of stabilizing the two adjacent fractures. One attractive treatment option is to stabilize the intertrochanteric fracture with a sliding hip screw and the femoral shaft fracture with an interlocked retrograde nail. If the femoral shaft fracture is transverse and not comminuted, retrograde inserted Ender nails can be used for femoral-shaft fixation in conjunction with a sliding hip screw. It is possible to use a cephalomedullary nail with screws anchored in the femoral head and neck, but results are poorer for stabilization of ipsilateral intertrochanteric-femoral shaft. fractures than for ipsilateral femoral neck-shaft fractures.

Considering the advantages of PFN A-II, a cephalomedullary device as mentioned before, in this study we are analysing the outcome of patients treated with it.

APPLIED ANATOMY

APPLIED ANATOMY

The intertrochanteric region of the hip consisting of the area between the greater and lesser trochanters represent a zone of transition from femoral neck to the femoral shaft. This area is characterized primarily by dense trabecular bone that serves to transmit and distribute stress similar to the cancellous bone of the femoral neck. The greater and lesser trochanters are the sites of insertion of the major muscles of the gluteal region, the gluteus medius and minimus, the iliopsoas and short external rotators. The Calcar femorale, a vertical wall of dense bone extending from the posteromedial aspect of the femoral shaft to the posterior portion of the femoral neck forms an internal trabecular strut within the inferior portion of the femoral neck and .intertrochanteric region which acts as a strong conduit for stress transfer.

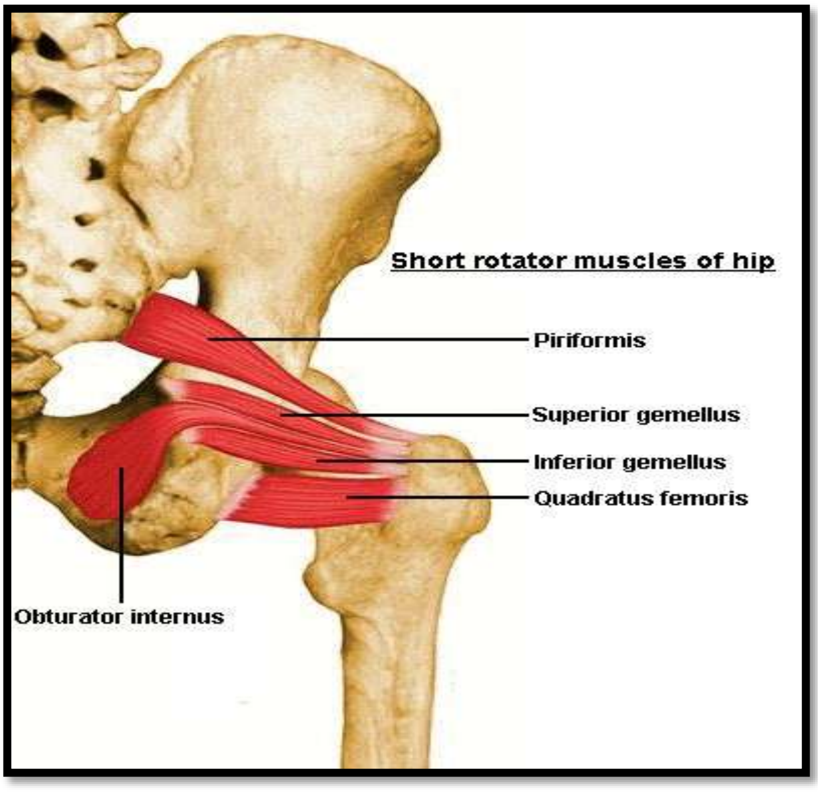


Figure 4 : Short External Rotators of Hip

The musculature of the hip region can be grouped according to function and location. The abductors of the gluteal region, gluteus medius and minimus which originate from the outer table of the ilium and insert on to the greater trochanter function to control pelvic tilt in the frontal plane. The gluteus medius and minimus along with tensor fascia latae are also the internal rotators of the hip. The hip flexors are located in the anterior aspect of the thigh include the sartorius, pectineus, iliopsoas and rectus femoris. Iliopsoas inserts on the lesser trochanter. Gracilis and the adductor muscles(longus, brevis and magnus) are located in the medial aspect of the thigh. The short external rotators, the piriformis, obturator internus. Obturator externus, superior and inferior gemelli and quadratus femoris all insert to the posterior aspect of the greater trochanter. The gluteus maximus originating from the ilium, sacrum and coccyx inserts onto the gluteal tuberosity along the linea aspera in the subtrochanteric region of the femur and the iliotibial tract

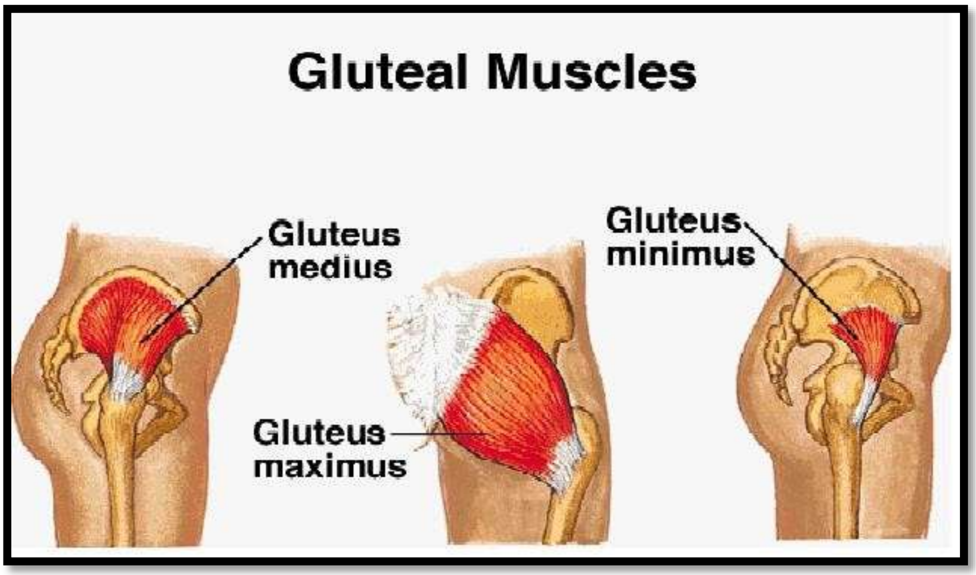


Figure 5 : Gluteus Muscles

INTERTROCHANTERIC LINE:

It marks the junction of anterior surface of the neck with shaft of femur. It begins above at the anterosuperior angle of the greater trochanter and is continuous below with the spiral line in front of the lesser trochanter. It provides attachment to the,

- Capsular ligament of the hip joint.
- Upper band of illiofemoral ligament in the upper part.
- Lower band of iliofemoral ligament in lower part; origin to the highest fibres of the vastus lateralis from the upper end and the origin to the highest fibres of vastus medialis from the lower end of the line.

INTERTROCHANTERIC CREST:

This marks the junction of posterior part of neck with shaft of femur. It begins above at the posterosuperior angle of greater trochanter and ends at the lesser trochanter. The rounded elevation, a little above its middle is called the quadrate tubercle, which provides insertion to quadratusfemoris extending to the area below it.

TRABECULAR PATTERN :

Ward[38] first described the internal trabecular structure of proximal femur in 1838. According to the wolf's law, trabeculae are oriented along the line of stress and thicker lines come from the calcar and raise superiorly into the weight bearing dome of the femoral head. Upper end of femur is composed of cancellous bone which shows two different types of trabeculae, namely the compression and tensile group.

The trabeculae6 have been divided into following five groups:

1. Primary compressive
2. Secondary compressive
3. Greater trochanteric
4. Primary tensile
5. Secondary tensile

Ward's triangle is bounded by primary compressive, secondary compressive and primary tensile group. Harty and Griffin[39] described the calcar femorale a dense vertical plate of bone extending from the posteromedial portion of the femoral shaft under the lesser trochanter and radiating lateral to the greater trochanter, reinforcing the femoral neck posteroinferiorly.

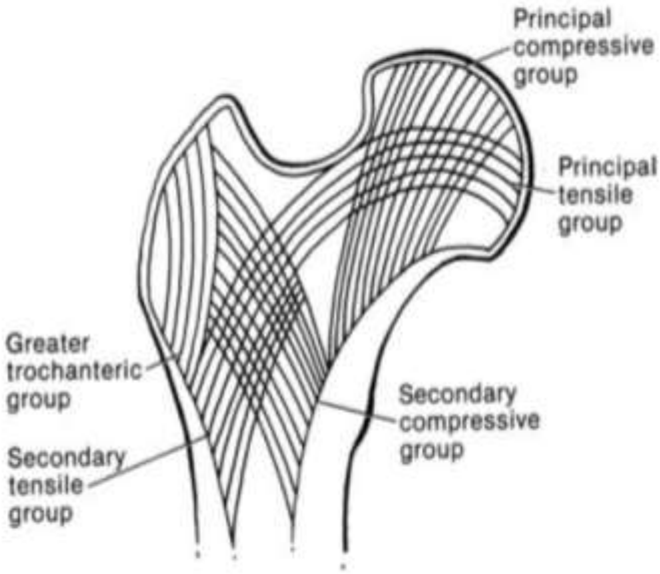


Figure 6 : Trabecular Pattern

Calcar femorale is a vertical plate of bone that extends from the posteromedial cortex of femur deep to the lesser trochanter and blends with the posterior cortex of the femoral neck. The calcar femorale is thickest medially and gradually thins as it passes laterally.

MOVEMENTS OF THE HIP JOINT AND THE MUSCLES PRODUCING THE MOVEMENTS

1. Flexion: It ranges from (0 - 90°) with extension of knee and (0 – 130°) with flexion of knee. Psoas major and the illiacus are the major contributors and minor contribution is by rectus femoris, Sartorius, pectineus and adductor longus in the early flexion from full extension.
2. Extension (0 to 15°): Gluteus maximus and hamstrings are active when the thigh is extended against resistance.
3. Abduction (0 – 45°): Gluteus minimus and gluteus medius are the major contributors. Sartorius, tensor fascia lata and piriformis are the minor contributors.
4. Adduction (0 – 40°): Adductor fibres of adductor magnus, adductor longus and adductor brevis are the main adductors Pectineus and gracilis are the minor adductors.
5. Medial rotation (0 – 30°): Anterior fibres of Gluteus medius, gluteus minimus and tensor fascia lata are the major contributors. Minor contribution by the adductors.

6. Lateral rotation (0 – 40°): Quadratus femoris, obturator internus, obturator externus, superior and inferior gamelli are the major contributors. Minor contribution by Sartorius, piriformis.
7. Circumduction: It is the combination of other movements.

SINGH’S INDEX FOR OSTEOPOROSIS:

This is used to grade osteopenia[38] based on the reduction introchanteric, tensile and primary compressive trabeculae. The grade is determined from the anteroposterior projection of an intact proximal femur. There are totally 6 grades30, graded from 1 to 6.

Normal – Grade 6: All trabecular groups are visible

Definite - Grade 3: Thinned trabeculae with a break in the principal tensile group

Severe – Grade 1: Only the primary compressive trabeculae are visible and they are reduced

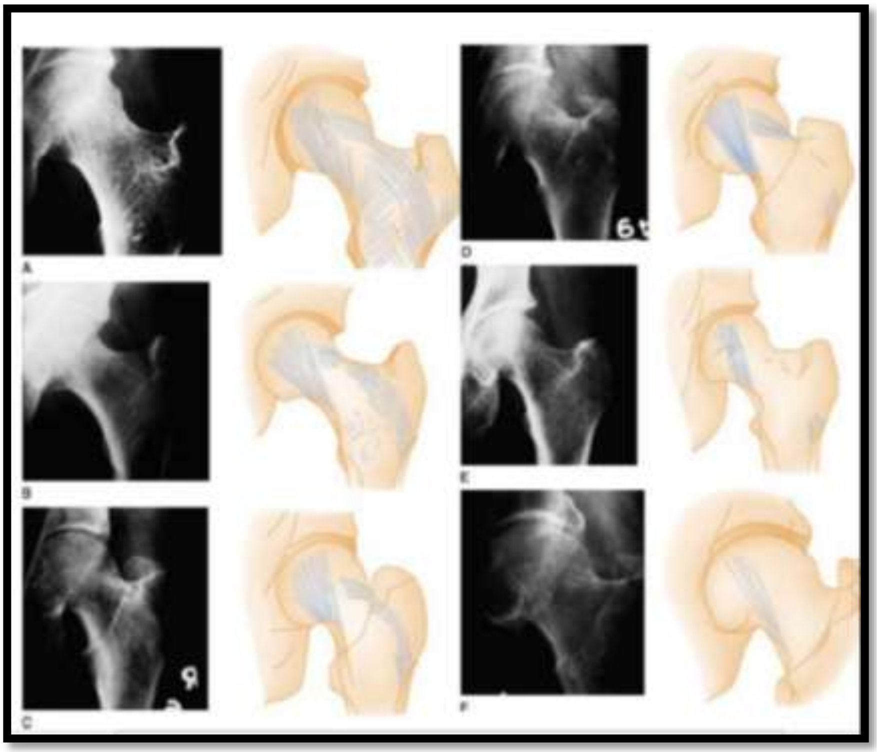


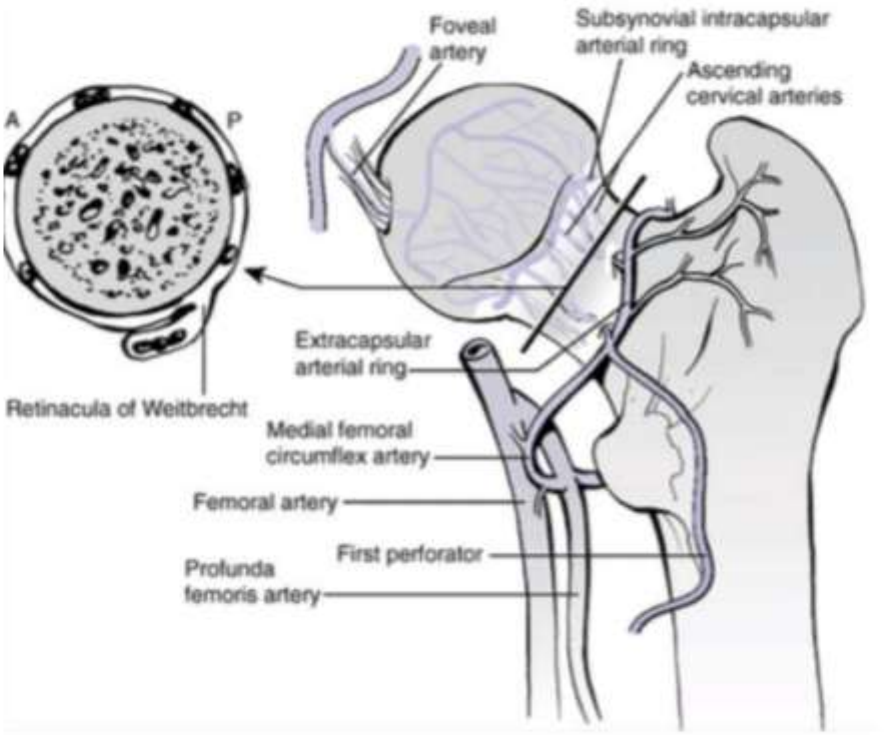
Figure 7 : Sigh’s Index of Osteoporosis

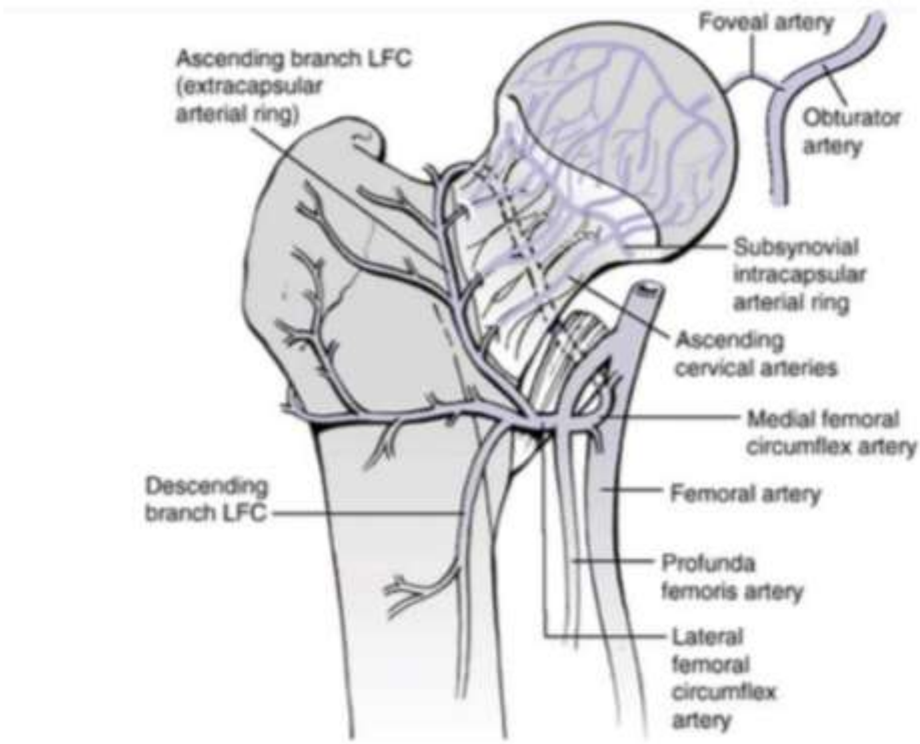
BLOOD SUPPLY OF THE PROXIMAL FEMUR

An extracapsular arterial ring is formed anteriorly by ascending branch of lateral femoral circumflex artery and posteriorly by medial circumflex femoral artery. The ascending cervical branch from this ring pierce the hip capsule near its distal insertion, becoming the retinacular arteries supply the femoral head. A subsynovial intracapsular arterial ring enter the femoral head and unite to form the lateral epiphysial arteries. These lateral epiphyseal arteries supply the majority of femoral head. The artery of ligamentum teres, a branch of obturator artery supply a small portion of femoral head around the fovea capitis.

The femur has very rich blood supply. Like most long bones, it can derive blood from periosteal vessels, but normally the major source is a single nutrient artery, which arises from first or second branch of profunda femoris artery. This nutrient vessel enters the bone near the medial side of linea aspera. Once inside the bone the. vessel arborise proximally and distally to form circulation of shaft. Similarly, the small periosteal vessels that enter the femur do along the linea aspera. These small periosteal vessels supply the outer one third to one fourth of the cortical bone, whereas the endosteal vessels supply the inner part. Inside the cortex, there is direct. communication between these two vessels. The normal blood flow is centrifugal, although some blood returns to the large venous sinusoids of the medullary canal. The medial circumflex artery is the major arterial supply. It passes around the femur proximal to the lesser trochanter gives off two or three branches to lesser trochanter. Its branches also supplies to the posterior surface of the base of the neck and as it passes more laterally it gives off .two or three branches into the upper surface of the neck near its junction with greater trochanter.

BLOOD SUPPLY OF THE PROXIMAL FEMUR





BIOMECHANICS OF HIP JOINT

The forces acting on the hip joint may be static or dynamic. Static force means application of external loads or forces in such a way that they are. balanced out each other and the joint is not subjected to acceleration[40]. Dynamic forces on the other hand refer to unbalanced loads or forces associated with acceleration / deceleration. The forces include both gravity as well as forces generated by muscle activity. The forces acting on the hip joint result from stabilizing the body's centre of gravity during stance and locomotion. The centre of gravity of the body is located just anterior to the second sacral vertebra. The horizontal distance from the centre of gravity of the body to the centre of hip joint is 8.5 to 10 cm. vertically the centre of gravity is about 3cm above the hip joint axis and during stance the centre of gravity is the same frontal plane as the common hip joint axis. The force acting on the hip joint is the sum of the supported body weight and tension developed in the abductors. The forces acting on the hip joint are normally quite large and much more than body weight. Loss of one pound of body weight relieves three pounds of pressure. A long femoral neck is an advantage to hip motion. The ratio of the two lever arms is important in the generation of total force acting on the hip joint. The shorter the horizontal distance from the centre of gravity of the body to the hip joint, less muscle force is required of abductors to balance it. Medial displacement of femoral head upon the pelvis may cause a greater decrease in joint pressure. If the individual leans the trunk directly over the weight bearing hip, the medial lever arm is reduced to zero so that no muscle force is necessary in the abductor tensor muscles (as in trendelenberg's gait) joint reaction force is reduced to body weight. If the centre of gravity is moved away from the weight bearing hip abductor force is more and hence the joint reaction force is increased.

BIOMECHANICS OF TROCHANTERIC FRACTURES

Operative treatment of intertrochanteric hip fractures with internal fixation creates a fracture fragment – implant assembly intended to withstand the forces acting on the fracture site. Since avoiding recumbency is often the goal of internal fixation[41] and since many patients with trochanteric hip fractures lack the balance, coordination and ability to avoid weight bearing upon the fractured femur, it is often necessary that the fracture fragment implant assembly be strong enough to withstand the body weight and the very considerable muscle forces which act on the trochanteric region of femur. These forces have been shown to be equivalent to as much as three times the body weight acting upon the femoral head. Creating a fracture fragment implant assembly capable of withstanding loads of this magnitude is the bio mechanical goal of the surgeon who elects upon the operative treatments of intertrochanteric fractures.

FRAGMENT GEOMETRY:

Much clinical attention is focussed upon the number, location and displacement of trochanteric fracture fragment. Comminution, especially if it involves size, fragment the posterior and medial portion of the trochanteric region is recognized as a major factor contributing to the complications of fixation. Multiple fragment with comminution extending into the medial and posterior femoral cortex is far more therefore likely to displace into considered unstable, while two parts varus and retroversion. Fractures with posterior and medial cortical comminution are trochanteric fractures are far more likely to be stable. Although reduction and inter.

fragmentary fixation of the lesser fragment of a comminuted unstable intertrochanteric .fractures can contribute to the stability of the post fixation assembly, in practice, interfragmentary fixation is time consuming, frequently disappointing and may contribute to infection and other biological complications of operative treatment. It is therefore generally agreed that one should ignore the lesser fragments and concentrate on gaining stable fixation of the major proximal fragment to the major distal fragment attaining posteromedial cortical contact.

MECHANISM OF INJURY

MECHANISM OF INJURY

Intertrochanteric fractures in young adults are the results of high energy trauma like road traffic accidents or fall from height. In contrast, 90 % of fractures occurring in the elderly are due to a simple fall. The tendency to fall increases with age and is exacerbated by several factors like poor vision, altered blood pressure, poor reflexes, decreased muscle power, vascular disease and co existing musculoskeletal pathology.

Cummings[42] and Nevitt identified four factors that determine whether a particular fall results in a fracture of the hip.

a. The fall must be oriented that the person lands on or near the hip
b. Inadequate protective reflexes that do not reduce the energy of fall
c. Deficient local shock absorbers (muscle and bone around the hip)
d. Insufficient bone strength at the hip – Osteoporosis.

SIGNS AND SYMPTOMS

Fractures may be undisplaced or impacted and, such patients may present with minimal pain at the hip or may present with thigh pain. They may be ambulant. Whereas patients with displaced fractures are clearly symptomatic usually cannot stand and nonambulant.

Patients with undisplaced fracture may present with virtual absence of clinical deformity whereas those with displaced fracture exhibit the classical presentation of shortened and externally rotated extremity. There may be tenderness on palpation in the area of the greater trochanter. Ecchymoses may be present and should be noted.

RADIOGRAPHIC AND OTHER IMAGING STUDIES

Standard radiographic examination includes AP view of the Pelvis, Intra-op AP and cross table lateral view of the proximal femur. The lateral radiograph can help to assess the posterior comminution of the proximal femur .in needed cases. An internal rotation view of the injured hip may be helpful to identify undisplaced fractures. Internally rotating the involved femur 10 to 15 deg offsets the anteversion of the femoral neck and provides a true AP view of the proximal femur A second AP view of the contra lateral side can be useful for preoperative planning.

FRACTURE CLASSFICATION

CLASSIFICATION

Few classifications have focussed on stability and anatomical pattern (Evans; Ramadier; Decoulx; & Lavarde) while others on maintaining reduction of various types (Jensen's modification of Evan's, Ender; Tronzo, AO). The commonly used classification is the Boyd and Griffin classification.

Boyd and Griffin Classification[11] (1949): His classification included all fractures from the extracapsular part of neck to a point 5 cm distal to the lesser trochanter.

Type 1: Fractures that extend along the. intertrochanteric line from the greater to the lesser trochanter. Reduction is usually simple and is maintained with little difficulty. Results are generally satisfactory.

Type 2: Comminuted fractures, the main. fracture being along the Intertrochanteric line but with multiple fractures in the cortex. Reduction of these fracture are more difficult because the comminution canvary from slight to extreme. A particularly deceptive form of the fracture is one wherein there is an anteroposterior linear Intertrochanteric fracture occurs as in type 1 but with an additional fracture in the coronal plane.

Type 3: Fractures that are basically subtrochanteric with at least one fracture passing across the proximal end of the shaft just distal to (or) at the lesser trochanter. Varying degrees of comminution are associated. These fractures are usually more difficult to reduce and result in more complications, both during operation and during convalescence.

Type 4 : Fractures of the trochanteric region and the proximal shaft, with fracture in at least two planes, one of which usually in the sagital plane and maybe difficult to see in the routine anteroposterior roentgenograms. If open reduction and internal fixation are used two plane fixation is required because of the spiral, oblique or butterfly fracture of the shaft.

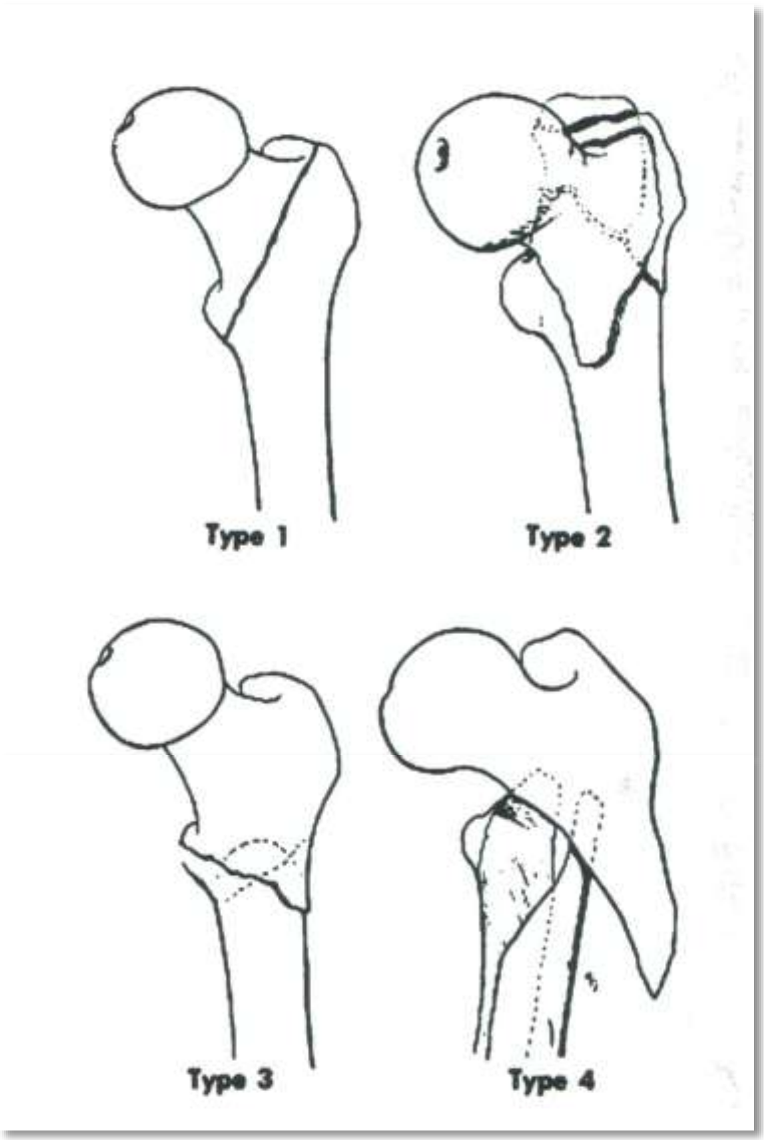


Figure 9 : Boyd and Griffin Classification

Evans[14] devised a widely used classification system based on the division of fractures into stable and unstable groups. He divided the unstable fractures further into those in which stability could be restored by anatomical or near anatomical reduction and those in which anatomical reduction would not create stability. In Evans type 1 fracture, the fracture line extends upwards and outwards from the lesser trochanter, in type 2, the reverse obliquity fracture, the major fracture line extends outward and downward from the lesser trochanter. Type 2 fractures have a tendency towards medial displacement of the femoral shaft because of the pull of adductor muscles.

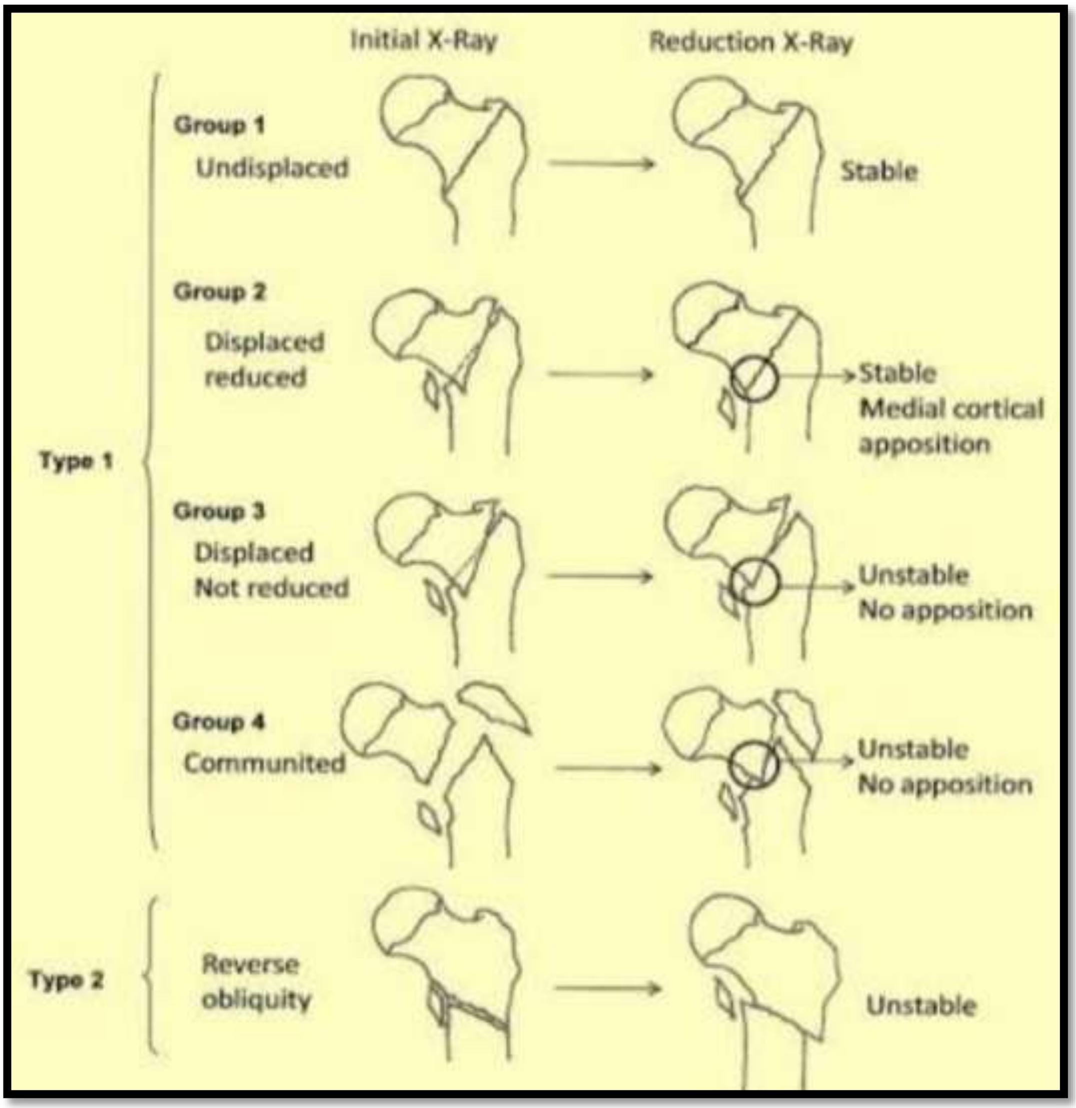


Figure 10 : Evan's Classification

In Orthopaedic Trauma Association. classification, Group 1 fractures are simple 2 part fractures, group 2 fractures are comminuted with a posteromedial fragment the lateral cortex of the greater trochanter however remains intact. Group Three fractures are those in which the fracture line extends .across both the medial and lateral cortices. This group includes the reverse obliquity pattern.

31-A Femur, proximal trochanteric

31-A1 Peritrochanteric simple

31-A1.1Along intertrochanteric line

31-A1.2 Through greater trochanter

31-A1.3 Below lesser trochanter

31-A2 Peritrochanteric multifragmentary

31-A2.1 With one intermediate fragment

31-A2.2 With several intermediate fragments

31-A2.3 Extending more than 1 cm below lesser trochanter

31-A3 Intertrochanteric

31-A3.1 Simple oblique

31-A3.2 Simple transverse

31-A3.3 Multifragmentary

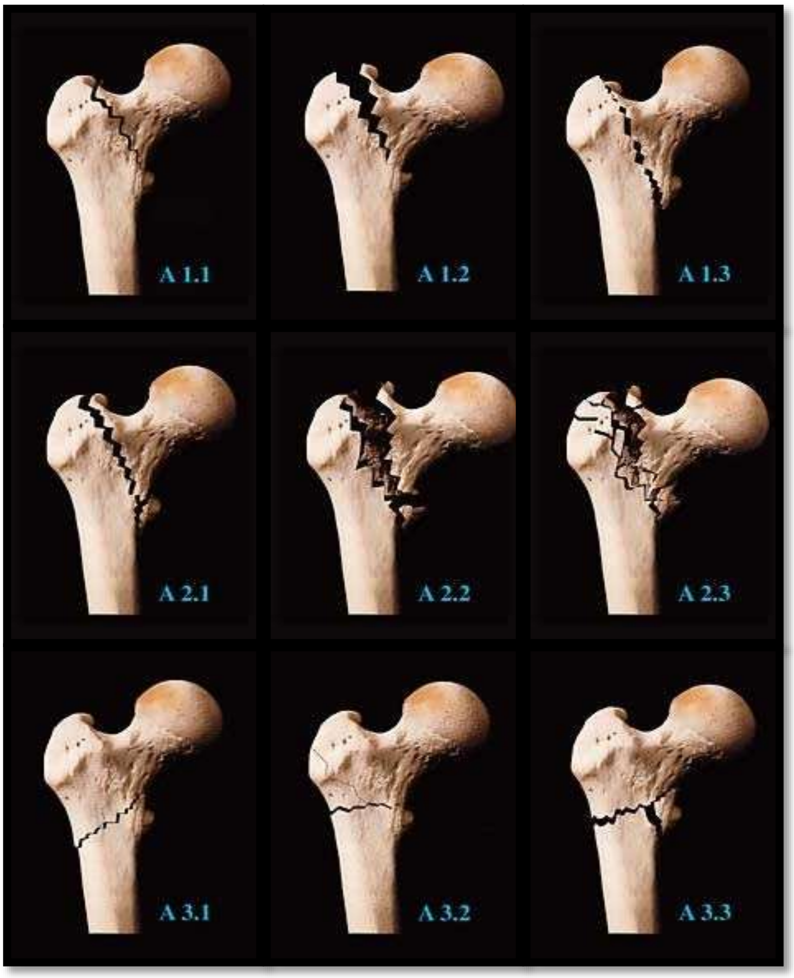


Figure 11 : AO Classification

Tronzo[15] incorporated Boyds and Griffin two plane instability in classification.

Type 1: Incomplete fractures

Type 2: Uncomminuted fractures, with or without displacement; both trochanters fractured

Type 3: Comminuted fractures, large lesser trochanter fragment; posterior wall exploded; neck beak impacted in shaft

Type 3 Variant: As above, plus greater trochanter fractured off and separated

Type 4: Posterior wall exploded, neck spike displaced outside shaft

Type 5: reverse obliquity fracture, with or without greater trochanter separation

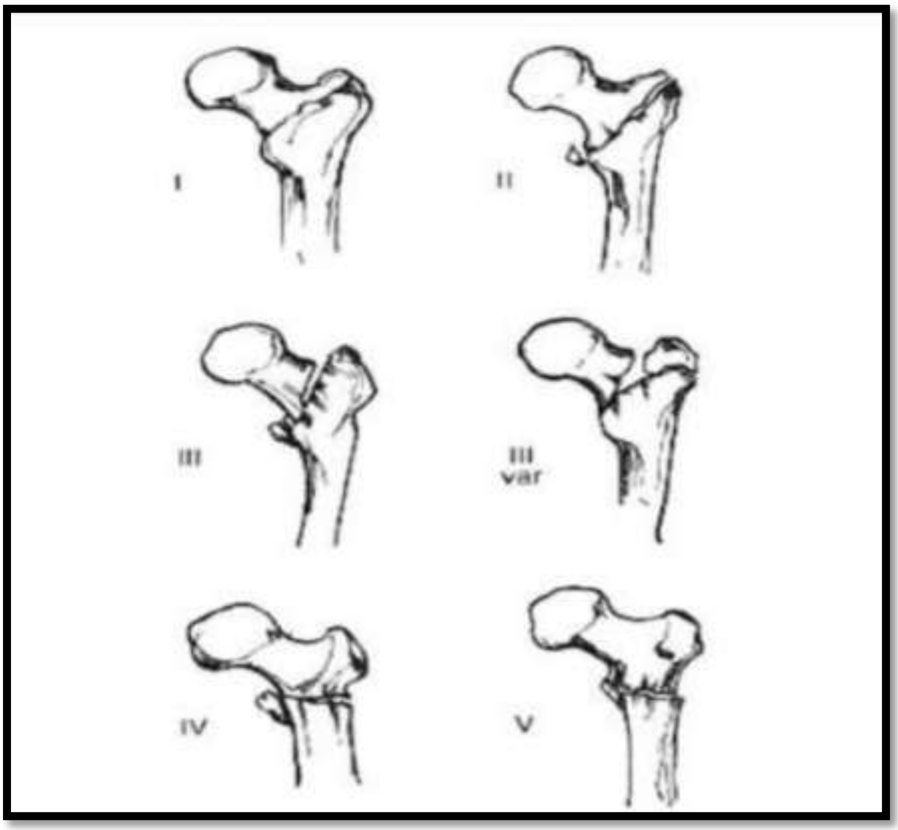


Figure 12 : Tronzo Classification

UNUSUAL FRACTURE PATTERNS

Basicervical neck fractures are located just proximal to or along the intertrochanteric line. Though basicervical fractures are considered extracapsular, this may not always be the case. Basicervical fractures are thus at greater risk of osteonecrosis than the more distal intertrochanteric fractures. Furthermore, basicervical fractures lack the cancellous interdigitation seen with fractures through the intertrochanteric region which acts more likely to sustain rotation of the femoral head during implant insertion.

IMPLANTS AND SURGICAL TECHNIQUES

INSTRUMENTS

Figure 13 - Hexagonal screw driver (locking nail with jig), b-entry awl, c-reamer, d- jig, e-lateral cortex reamer, f-reamer (11mm).

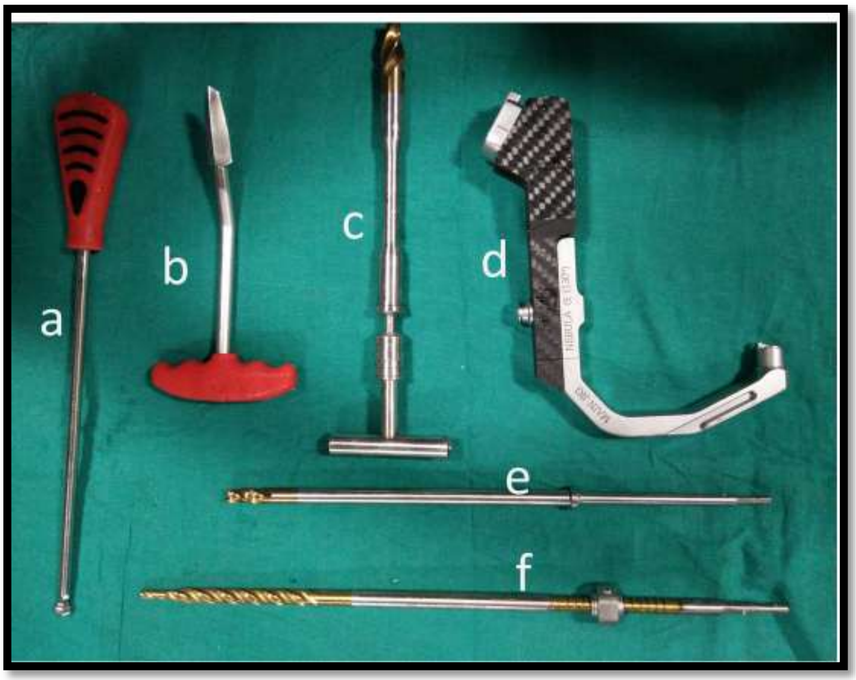


Figure 14 : g, h – PFN A-II nail, i,j – jig & cannula, k -driver for helical blade l- measuring gauge, m-helical blade

PFN A -II Implant measurements

Length of short PFN A II	170,200,240 mm
Proximal Diameter	16.5mm
Proximal Nail Angulation	5^0
Distal diameter	9, 10, 11,12mm
Helical blade diameter	14mm
Helical blade length	75-120mm
Helical blade reamer diameter	11mm
Distal locking bolt	4.9mm

SURGICAL TECHNIQUE

Evaluation of the appropriateness of an intramedullary device and estimation of appropriate nail diameter, helical blade length are performed using preoperative radiographs and templates. The patient is positioned supine on a fracture table, with both lower extremities resting in padded foot holders.

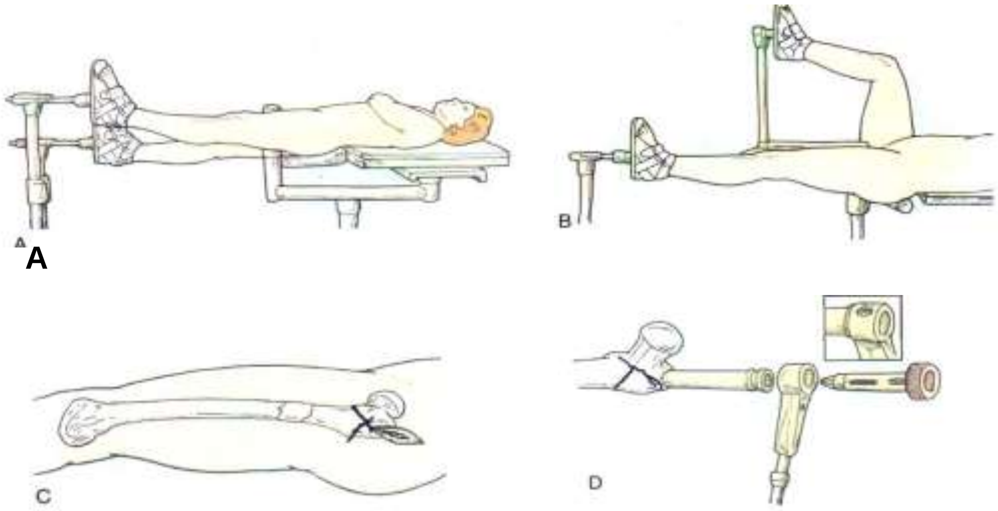
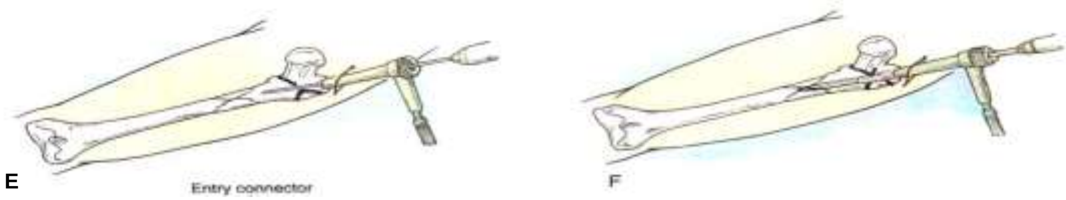


Figure 14 : Position and entry point

The fracture is reduced as described with the use of a sliding hip screw, and the leg is placed in neutral or slight adduction to facilitate nail insertion through the greater trochanter; contra lateral leg is positioned so as to allow an unimpeded lateral radiograph.



Since it is extremely difficult to insert an intramedullary nail with the hip abducted, abduction of the lower extremity is not used to correct the varus malreduction. Although it is possible to insert the intramedullary nail component of the device with the fracture unreduced and the leg adducted, followed by fracture reduction and lag screw insertion with the leg abducted, doing so can be very difficult technically. Therefore, if a varus reduction cannot be corrected without placement of the leg in abduction, it is preferable either to perform an open reduction with direct fracture exposure or to use a sliding hip screw for fracture stabilization. A lateral straight incision is made from tip of the greater trochanter extending proximally for 4 to 6 cm; the gluteus medias muscle is dissected in line with its fibers. If an open reduction is required, one can extend the incision distally, incising the iliotibial band in the line with the skin incision. In this case, the vastus lateralis muscle is reflected anteriorly to expose the proximal femoral shaft. The entry point for an intramedullary hip screw is at the posteromedial tip of the greater trochanter, halfway between its anterior and posterior extent. In younger individuals, particularly those with subtrochanteric fractures, it may be necessary to ream the femoral isthmus to accommodate the intramedullary nail; a ball tipped guide wire can be placed down the femoral shaft and a flexible cannulated reamer used to enlarge the proximal shaft to the appropriate diameter. In the elderly who have larger diameter medullary canals, this step is usually not necessary. The appropriately sized intramedullary nail is then assembled with its corresponding intramedullary angle guide attachment. It is imperative that the appropriate angle guide targets the proximal and distal holes in the nail using the drill sleeves and guide pin prior to device insertion. The nail is inserted by hand through the greater trochanter into the proximal femur. One should avoid use of excessive force, which may produce comminution of the proximal femoral shaft. It is also important to use frequent fluoroscopic evaluation to follow the progression of the nail as it is inserted.

The nail is positioned to allow proper positing of helical blade in the femoral neck and head. The drill sleeve is inserted into the angle attachment and pushed up to the lateral femoral cortex. It is important that the sleeve rest against bone and not the vastus lateralis muscle. The threaded guide pin is then inserted through the sleeves into the femoral neck and head using image intensification and advanced until it is 5 to 10 mm from the hip joint. Guide. wire should be central / slightly postero-inferior to the centre in AP and Lateral fluoroscopic images. If the guide pin is not correctly positioned, it should be removed and the nail position confirmed.

Figure 15 : Shows insertion of nail and drilling over guide wire for helical blade

A cannulated reamer is advanced over the guide pin to the appropriate depth and then the helical blade is jammed into the head and neck after measuring appropriate size. Distal targeting, is performed using the drill sleeves.

Figure 16 : Helical blade banged with mallet

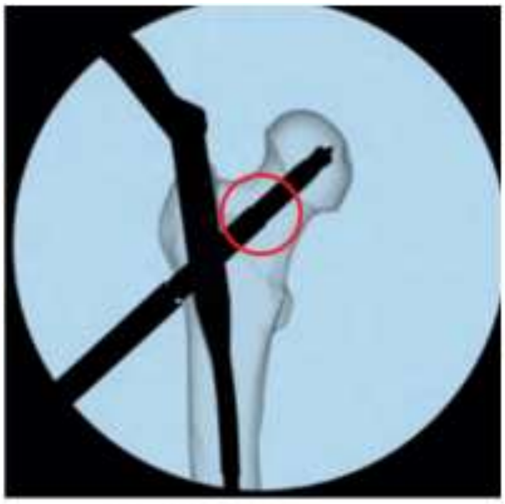


Figure 17 : Locking of blade

POSTOPERATIVE FRACTURE CARE

The mobilization of hip fracture patients out of bed begin and ambulation training be initiated on postoperative day1. Furthermore, any patient who has been surgically treated for an intertrochanteric fracture should be allowed to bear weight as tolerated. Restricted weight bearing after hip fracture has little biomechanical justification, since activities such as moving around in bed and use of a bedpan generate forces across the hip approaching those resulting from unsupported ambulation. Even foot and ankle range-of-motion exercises performed in bed produce substantial loads on the femoral head secondary to muscle contraction.

Several studies have demonstrated that unrestricted weight bearing does not increase complication rates following fixation of intertrochanteric fractures.

COMPLICATIONS

LOSS OF FIXATION

Helical blade cutout from the femoral head generally occurs within 3 months of surgery and is usually due to

a) eccentric placement within the femoral head

b) improper reaming that creates a second channel;

c) inability to obtain a stable reduction;

d) unstable trochanteric fractures

Loss of fixation is minimized with PFN

- By intramedullary position of Nail
- Biomechanically shorter moment arm
- Prevent the excessive collapse of the Proximal fragment
- Prevent gross medialisation of the distal fragment

Failure management

a) Revision ORIF, which may require methylmethacrylate;

b) Conversion to prosthetic replacement

NONUNION

Nonunion following surgical treatmen.t of intertrochanteric fracture occurs in less than 2%of patients; its rare occurrence is largely due to the fact that the fracture occurs through well-vascularized cancellous bone. The incidence of nonunion is highest in unstable fracture patterns. Most intertrochanteric nonunions follow unsuccessful operative stabilization, with subsequent varus collapse, screw cutout through the femoral head. Another possible etiology for intertrochanteric nonunion is an osseous gap secondary to inadequate fracture impaction, but this is less with PFN A II.

Intertrochanteric nonunion should be suspected in patients with persistent hip pain that have radiographs revealing a persistent radiolucency at the fracture site 4 to 7 months after fracture fixation. Progressive loss of alignment strongly suggests nonunion, although union may occur after an initial change in alignment, particularly if fragment contact improves. Abundant callus formation may be present making the diagnosis of nonunion difficult to confirm. Tomography evaluation may help to confirm the diagnosis; otherwise the diagnosis may not be possible until the time of surgical exploration. As with any nonunion, the possibility of an occult infection must be considered and excluded. In some cases, with good bone stock, repeat internal fixation combined with a valgus osteotomy and bone grafting can be considered however, in most elderly individuals, conversion to a Calcar replacement prosthesis is preferred.

MALROTATION DEFORMITY

The usual cause of malrotation deformity after intertrochanteric fracture fixation is internal rotation of the distal fragment at surgery. In unstable fracture patterns, the proximal and distal fragments may move independently; in such cases, the distal fragment should be placed in neutral to slight external rotation during fixation of the plate to the shaft. When malrotation is severe and interferes with ambulation, revision surgery with plate removal and rotational osteotomy of the femoral shaft should be considered.

OTHER COMPLICATIONS

Osteonecrosis of the femoral. head is rare following intertrochanteric fracture. No association has been established between location of the implant within the femoral head and the development of osteonecrosis, although one should avoid the insertion of hip screw in the postero-superior aspect of the femoral head because of the proximity of the lateral epiphyseal artery system.

Laceration of the superficial femoral artery by a displaced lesser trochanter fragment has been reported, as well as binding of the guide pin within the reamer, resulting in guide pin advancement and subsequent intraarticular or intrapelvic penetration.

POST OPERATIVE FEMORAL SHAFT FRACTURE

Older generation cephalomedullary Nails had very large distal locking screw near the tip of the Nail with associated risk of stress riser near the Nail Tip causing post operative femoral shaft fracture near the Nail tip.

In PFN A II stress riser effect is decreased by the tapered distal end of the Nail and the distal locking screws are placed more proximally on the Nail.

MATERIALS AND METHODS

MATERIALS AND METHODS

At our institution we selected 20 cases (21 hips – one patient had bilateral trochanteric fracture) of unstable trochanteric fractures for this prospective study.

There were 11 males and 9 females included

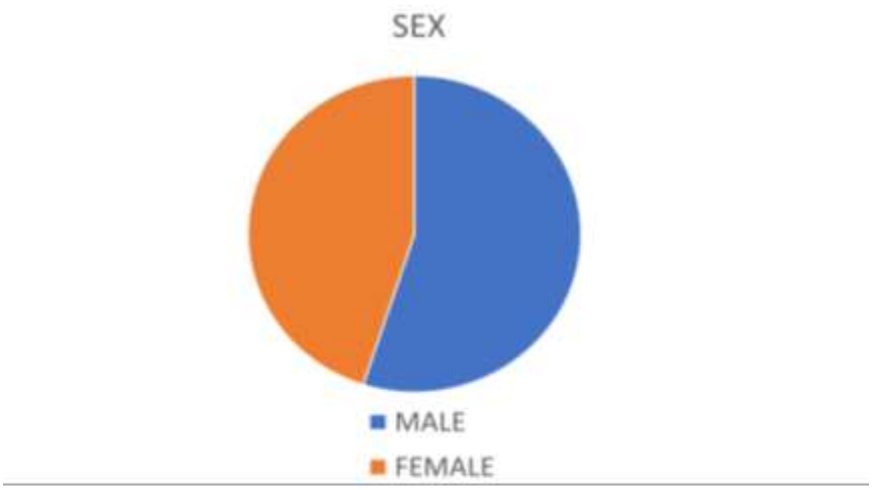


Figure 18 : Sex Distribution

Age groups of patient varied from 45 years to 85 years. The distribution is charted below

Figure 19 : Age Distribution

Right side involved in 10 cases Left side involved in 9 patients, bilateral in 1 patient.

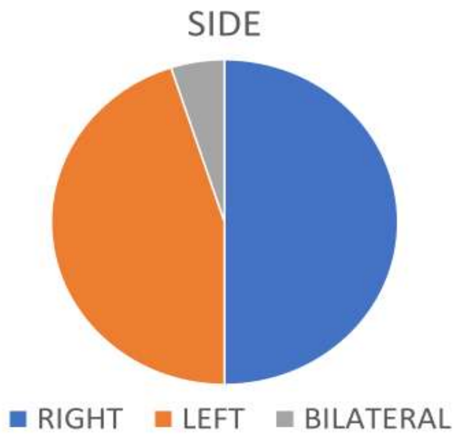


Figure 20 : Fracture side Distribution

Mode of injury was RTA (Road traffic accident) in 10 patients and Self-fall in 11 patients .

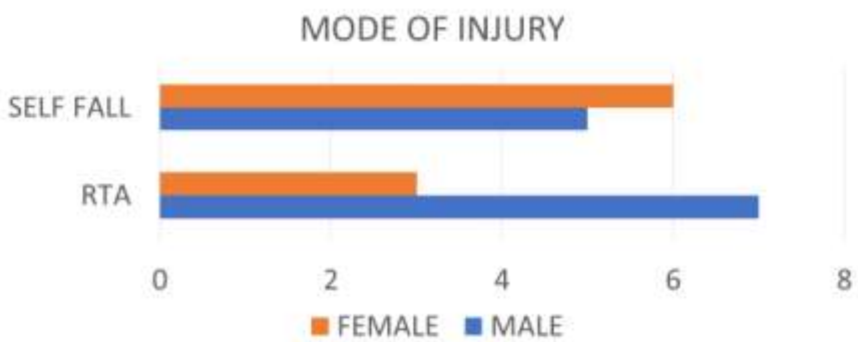
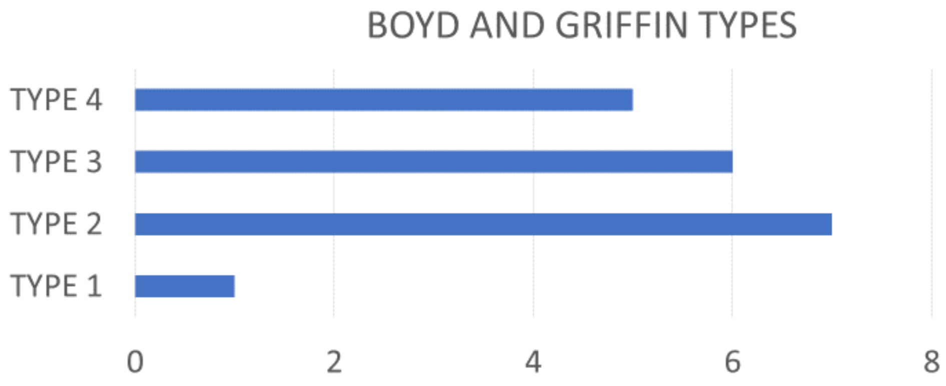
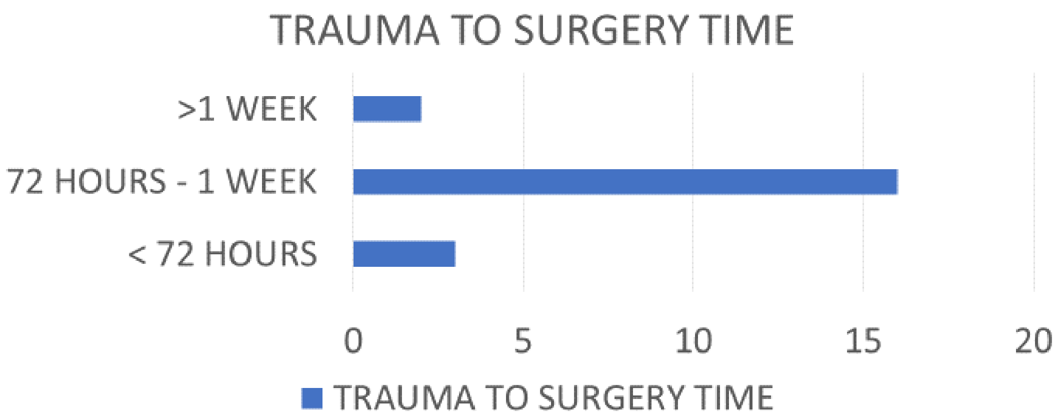


Figure 21 : Mode of injury

Among patients, Boyd and griffin fractures types are as classified below with type 2 being predominant type and type 1 being least type. The classification is based on the pre-operative AP view with traction and internal rotation taken at the time of admission.



The trauma to surgery time is represented below with most of the patients operated in an interval of 3 to 7 days post-trauma.



INCLUSION CRITERIA :

- Patients > 18 years of age presenting to our causality with intertrochanteric femoral fractures with all Boyd and Griffin types (1-4)
- Both displaced and Undisplaced fractures
- Fractures less than 1 week duration
- Without any other associated fractures

EXCLUSION CRITERIA:

- Fractures with non union changes
- Old malunited intertrochanteric fracture
- Patients with arthritic changes in hip joint
- Pathological fractures

STUDY CENTRE : Department of orthopaedics, Govt. Kilpauk Medical College and Government Royapettah Hospital, Royapettah, Chennai

STUDY PERIOD: All patients are followed up for period of atleast 6 months

VARIABLES STUDIED : Functional outcome based on pain, function, absence of deformity and range of motion using **HARRIS HIP SCORE** .

DATA COLLECTION AND METHODS:

Collection of data as per proforma with consent from patients admitted in Orthopaedics ward at Government Royapettah hospital and Govt. Kilpauk medical College.

SURGICAL TECHNIQUE :

All patients were operated on fracture table with the technique described previously. All patients were operated under Spinal anaesthesia.

POST-OP PROTOCOL

- Routine Post Operative Protocol and chest physiotherapy.
- Hip and knee Mobilisation from 1^{st} post-op day .
- Weight-bearing increased gradedly .
- Peri-operative DVT prophylaxis with enoxaparin .
- Suture removal on 12^{th} post-operative day

- Regular Follow Up with periodical X rays at 3rd and 6th months .

ANALYSIS PLAN:

Analysis of Functional outcome of Intertrochanteric fractures treated by Proximal Femoral Nailing Anti-rotation-II using HARRIS HIP SCORE[43]

HARRIS HIP SCORE

PAIN

- None or ignores it (44)
- Slight, occasional, no compromise in activities (40)
- Mild pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require occasional pain medical stronger than aspirin (20)
- Marked pain, serious limitation of activities (10)
- Totally disabled, crippled, pain in bed, bedridden (0)

LIMP

- None (11)
- Slight (8)
- Moderate (5)
- Severe (0)

SUPPORT

- None (11)
- Cane for long walks (7)
- Cane most of time (5)
- One crutch (3)

- Two crutch (2)
- Two crutch or not able to walk (0)

DISTANCE WALKED

- Unlimited (11)
- Six blocks (8)
- Two or three blocks (5)
- Indoors only (2)
- Bed and chair only (0)

SITTING

- Comfortably in ordinary chair for one hour (5)
- On a high chair for 30 minutes (3)
- Unable to sit comfortably in any chair (0)

ENTER PUBLIC TRANSPORTATION

- YES (1)
- NO (0)

STAIRS

- Normally without using a railing (4)
- Normally using a railing (2)
- In any manner (1)
- Unable to do stairs (0)

PUT ON SHOES AND SOCKS

- With ease (4)
- With difficulty (2)

- Unable (0)

ABSENCE OF DEFORMITY (all yes=4, less than 4=0)

- Less than 30 degree fixed flexion contracture
- Less than 10 degree fixed abduction
- Less than 10 degree fixed internal rotation in extention .
- Limb length discrepancy less than 3.2 cm.

RANGE OF MOTION (* indicates normal)

- Flexion (*140)
- Abduction (*40)
- Adduction (*40)
- External rotation (*40)
- Internal rotation (*40)

Range of motion scale

- 211-300 degree (5)   161-210 degree (4)
- 101-160 degree (3)   61-100 degree (2)
- 31- 60 degree (1)   0-30 degree (0)

The grading of Harris hip score(TOTAL-100) and the comparative results are as following

- < 70 - poor
- 70-79 - fair
- 80-89 – good
- 90-100 – excellent

OBSERVATION AND RESULTS

OBSERVATION AND RESULTS

The results of the study are summarized as below:

The time duration of surgery of the patients varied from 37 mins to 98 mins . The distribution of patients with Boyd and griffin types are charted below against time duration of surgery

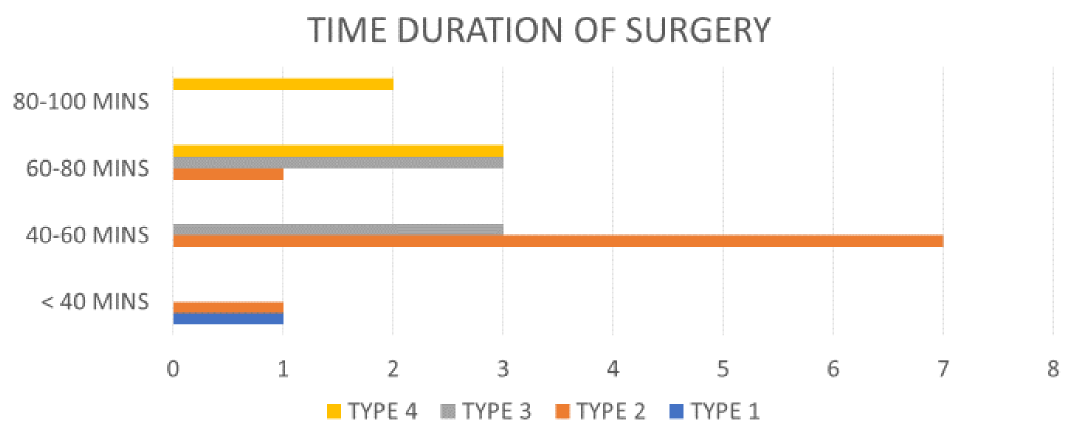


Figure 21 : Distribution of patients based on time duration of surgery

The number of fluoroscopy shots used during surgery was also less. The data is charted below, less than ten shots in 3 patients, 10- 15 shots in 13 patients, more than 15 shots in 5 patients.

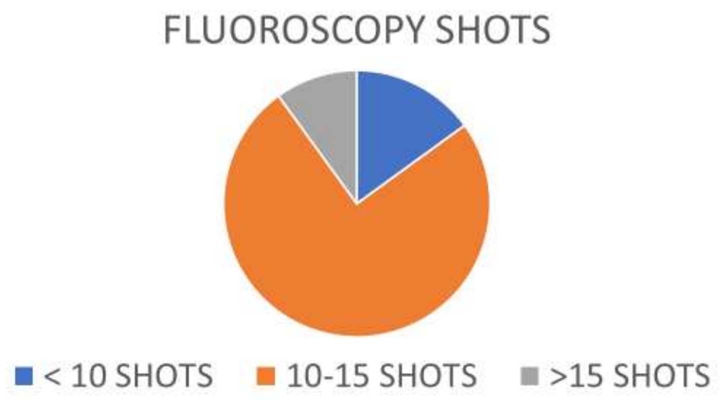


Figure 22 : Fluoroscopy Shots Distribution

The blood loss during surgery is also less in these patients with less than 50 ml in 1 patient, between 50-100 ml in 7 patients, between 100-150 ml in 12 patients, more than 150 ml in 1 patient .

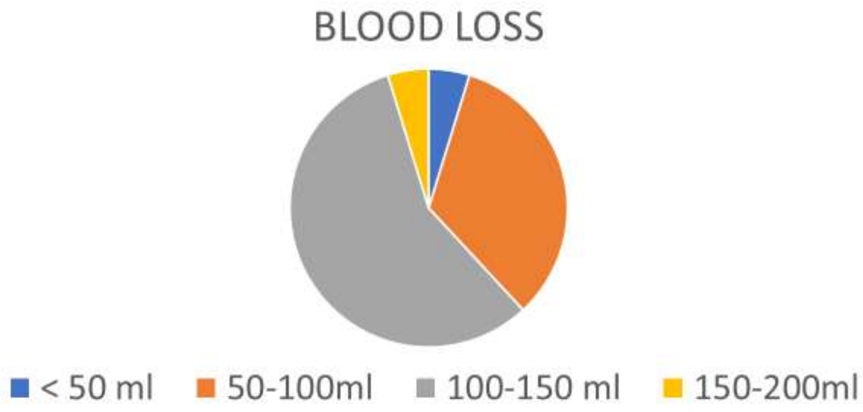


Figure 23 : Blood Loss

The HARRIS HIP SCORE grading was done and 5 patients were graded excellent, 11 as good, 4 as fair and none as poor. The patient with bilateral trochanteric fracture was graded good. Among excellent 3 were male and 2 female, among good cases 7 were male and 4 were female, among fair cases 1 was male and 3 were female.

Figure 24 : Harris Hip Score

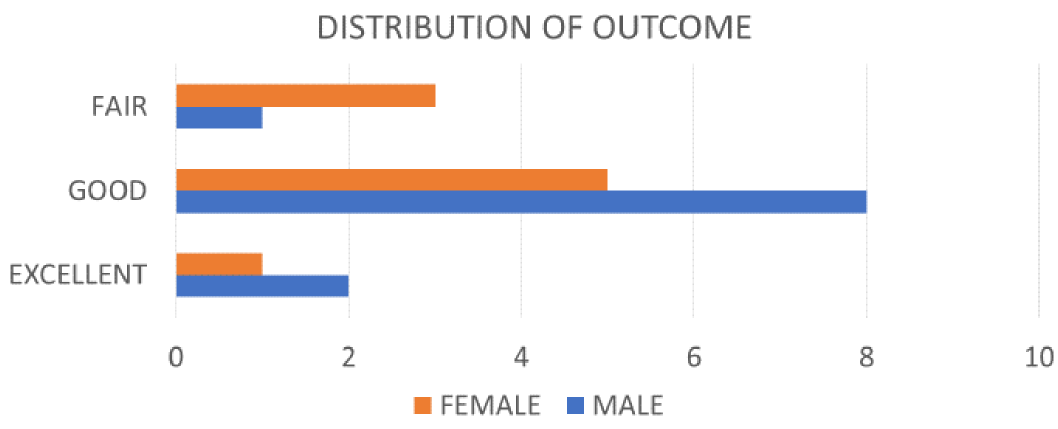


Figure 25 : Distribution of Outcome

The distribution of outcome among various age groups is shown below, irrespective of the age group "good" outcome was seen in most of the patients. Fair outcome was seen in patients above the age group of 65 only.

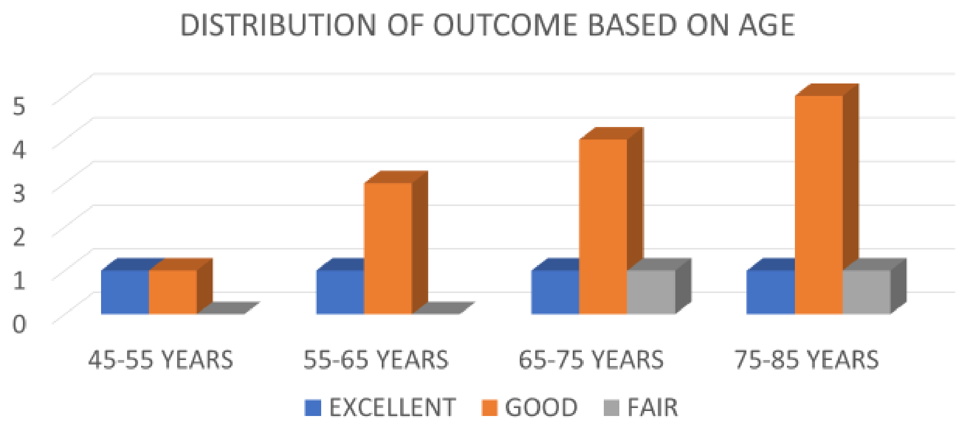


Figure 26 : Distribution of Outcome based on Age

The distribution of outcome grades among the various types of intertrochanteric fractures are shown below. The type 1 fractures had excellent outcome, all type 2 had good outcome, type 3 and 4 had excellent, good and fair outcome.

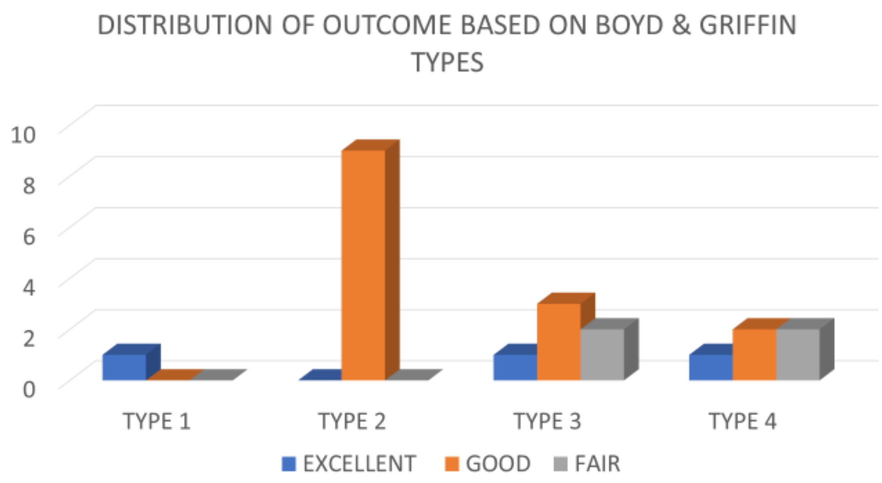


Figure 27 : Distribution of Outcome Based on Boyd and Griffin Types

Radiographically the mean time for union was about 13.09 weeks. The time for union ranged from 12 weeks to 16 weeks.

Figure 28 : Time of Union Distribution

The chart below depicts the sex wise distribution of time for union

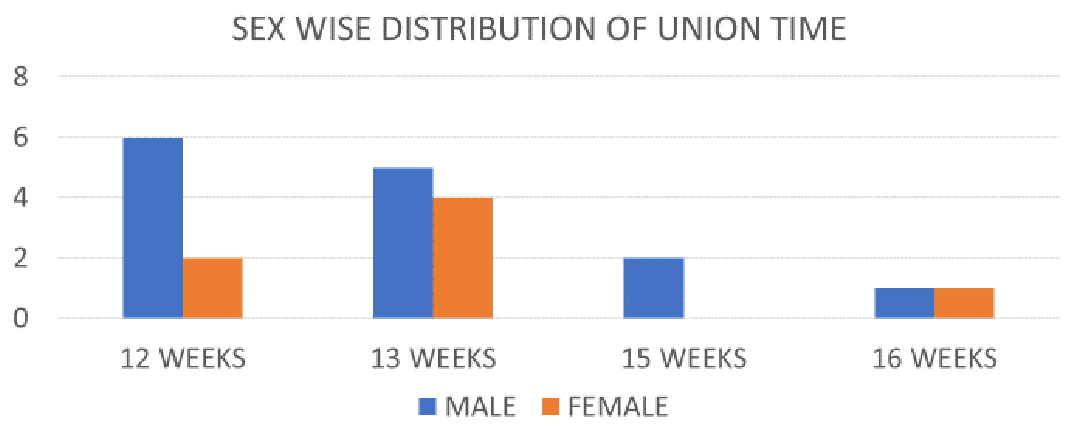


Figure 29 : Sex Wise Distribution of Union Time

The chart below depicts the age-group wise distribution of time for union

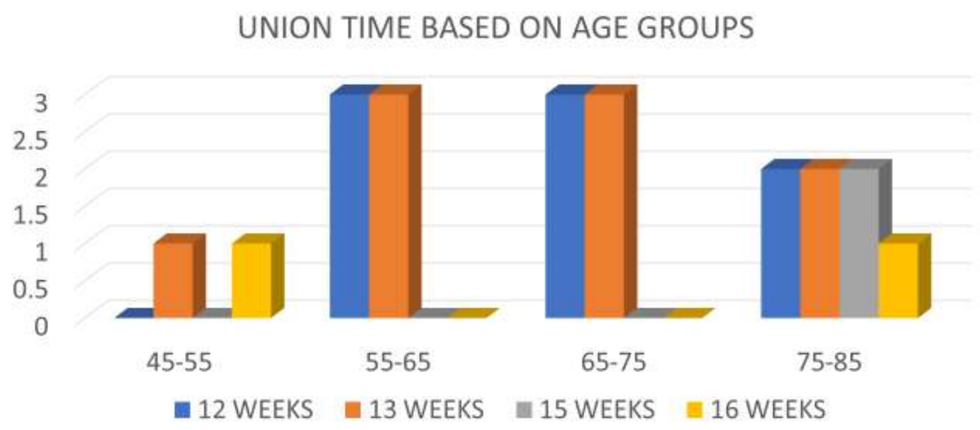


Figure 30 : Union Time Based on Age Groups

The chart below depicts the Boyd and griffin types and time for union in our study. It shows that most of type 1, 2 and 3 fractures united at an earlier time.

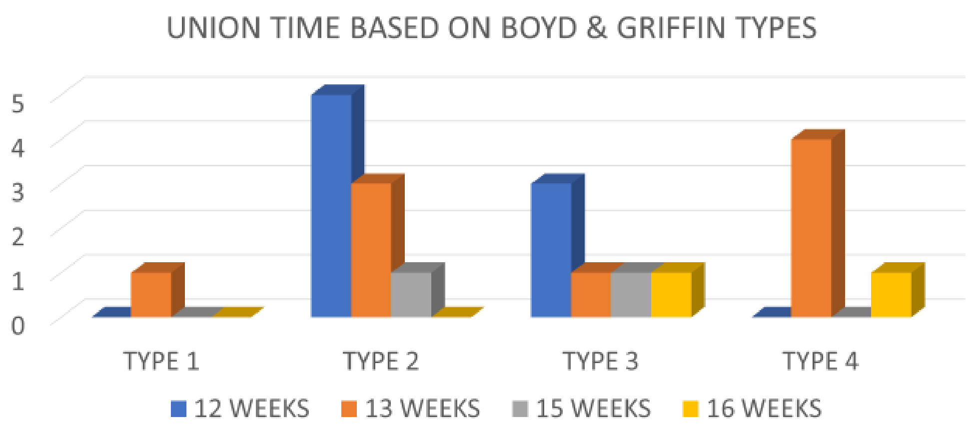


Figure 31 : Union Time Based of Boyd and Griffin Types

The length of hospital stay varied from 5- 24 days (with mean of 11 days). The length of hospital stay is charted below

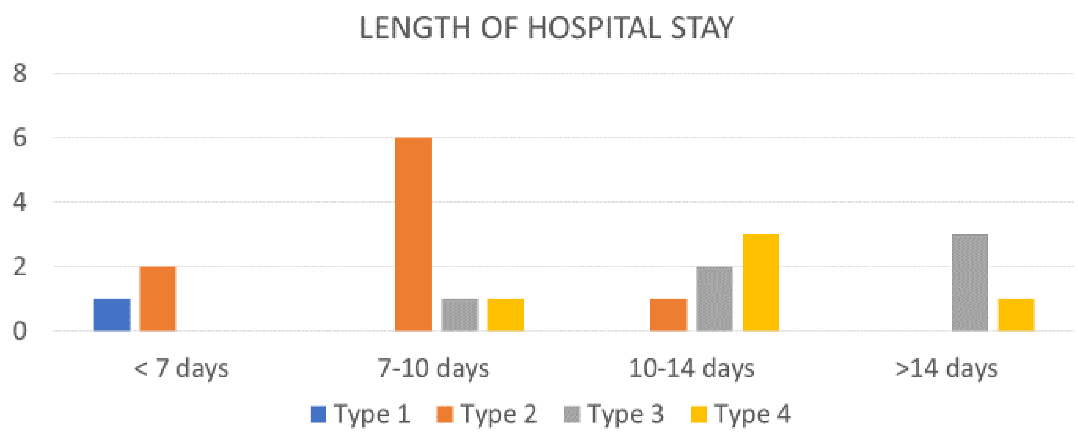


Figure 32 : Length of Hospital Stay Distribution

COMPLICATIONS:

The complications which occurred in the study and the number of patients affected are charted below.

Bed sore occurred in 3 patients (male-1, female-2), superficial infection occurred in 3 male patients which resolved with antibiotics, 3 patients had deep infection (male-2, female-1) which resolved with debridement and antibiotics, abductor lurch occurred in 1 female patient post-op hip pain occurred in 2 patients (male-1, female-1). There were no cases of helical screw cut-out, revision surgery, non-union or deep vein thrombosis in our study.

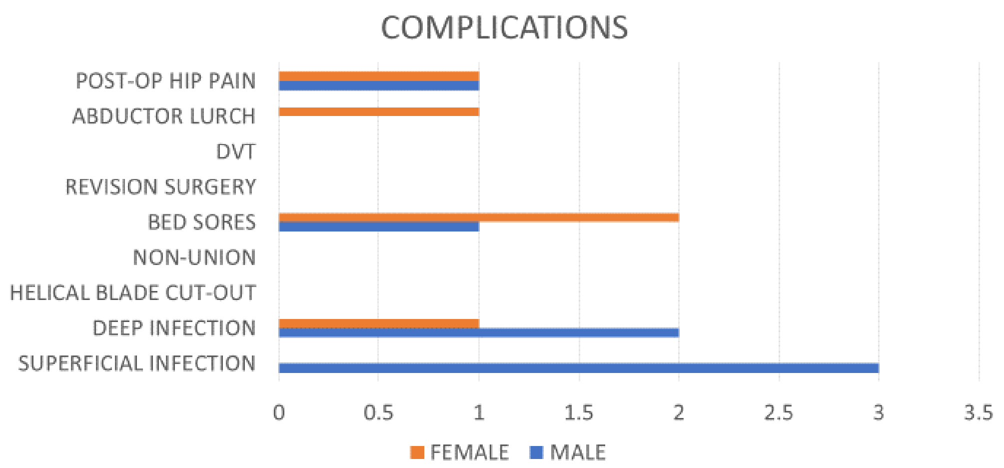


Figure 33 : Distribution Of Complications

Patients were evaluated clinically and radiologically at 3 weeks interval for first 3 months and there after monthly for the next 3 months and bimonthly for next 12 months. During follow up the Harris Hip Score was evaluated at 3 months and 6 months post operatively. Various parameter like pain, limp, use of support, distance walked, stair climbing, sitting, absences of deformity, range of motion were evaluated using Harris Hip Score.

SUMMARY OF RESULTS :

Average Operating Time	**62.6 min**
Average Blood Loss	**130 ml**
Abductor Lurch	**1 case**
Post-op hip pain	**2**
Helical blade cut-out	**0**
Average Fracture Union	**13.0 weeks**
Average Image Intensifier shots	**13.5 Shots**
Average Harries Hip score at 6months	**82.3**

DISCUSSION

DISCUSSION

The PFN A-II is an effectively designed intramedullary load - sharing device. It incorporates the principles and theretical advantages of the Zicker Nail, Dynamic hip screw locked intramedullary nail , with modifications for Asian population.

Biomechanically PFN A-II , just like the conventional PFN, is more stiff, it has shorter moment arm i.e. from the tip of helical blade to the center of femoral canal whereas the DHS has a longer moment arm undergoes significant stress on weight bearing and hence higher incidence of Lag screw cut out and varus malunion. The larger proximal diameter (17 mm) of the PFN A-II compared with PFN (15 mm) gives additional stiffness to the nail. Minimal blood loss, shorter operative time, early weight bearing, less chances of implant failure, minimal fluoroscopy time, easier helical blade insertion (compared with cumbersome lag screw and derotation screw), lesser chances of post op hip pain, better performance than any other implant in elderly osteoporotic patients are all advantage of PFN A-II.

In the current study the union rate was 100%. There were no cases of preoperative and postoperative femoral fractures. There were no cases of varus mal-union.

The average blood loss in patients treated with the PFN A-II nail was 130 ml, ranging from 50 to 275 ml. The results were comparable with Levent karapinar et al. study.

Average blood loss	**Levent karapinar et al. 127ml** **Yu.W.Zhang et al. 180ml** **J Zou, Y Xu et al. 180ml** **Li J et al. 131.86ml**	**Our series 130 ml**

Average operating time in our series was 62.6 minutes. In our initial cases operating time was on the higher range (Range 43 – 82 min). With experience the operating time reduced. The operating time were more in. type 3 and 4 of Boyd and Griffin types compared with other types.

Results were comparable to the series of Yu.W.Zhang et. al.[44] and J Zou et.al[45].

Average operating time	**Leventkarapinar et al.**[46] **-44.7min** **Yu.W.Zhang et al.** [44] **-55.6min** **J Zou, Y Xu et al.** [45]**- 68 min** **Li J et al.**[47] **– 66.25 min**	**Our series 62.6min**

The use of image intensifier was 13.5 shots in patients treated with the PFN, which was comparable with the above mentioned studies. In our study it ranged from 8 – 20 shots. Fluoroscopy was more needed in type 3 & 4 Boyd and griffins classification.

The time to union was 13.09 weeks in our study ranging from 12 to 16 weeks. This was comparable to Levent karapinar et.al. [46]

Average union time	**Leventkarapinar et al [46] 14weeks Yu. W. Zhang et al [44] 15.7 weeks J Zou, Y Xu et al [45] Li J et al [47] 12.5 weeks**	**Our series 13.09 weeks**

The average HARRIS HIP SCORE[43] in our patients was 79.8 (at the end of three months) and 82.3 (at the end of six months). Most of them were graded as "good" as per HARRIS HIP SCORING. Fair scores were seen with higher age group and higher Boyd and Griffin types.

Average HARRIS HIP SCORE	**Leventkarapinar et al [46] 80.75 Yu.W.Zhang et al [44] 81.90 Li J et al [47] 86.19**	**Our series 82.3**

The length of hospital stay in our study was 11 days (5 -24 days) and it was comparable to Li J et.al. [47] (10.8 days) and other studies .

Even other studies mentioned above in comparison have higher exposure fluoroscopy and greater blood loss in types 3 and 4 of Boyd and Griffin.

The complications in our study included bed sores, superficial and deep infections (which settled subsequently with Intravenous antibiotics and debridement respectively), abductor lurch, post-op Hip pain. These were also present in other studies of PFN A-II with comparable rates.

A major complication of screw cut out was reported in other studies in few cases Two cases of helical blade cut out (out of 42 patients) was reported by Levent karapinar et al. Our study dint have any complications of screw cut out or revision surgeries as in our study all helical blades were placed as per the tip apex distance as mentioned by Baumgartener et al. Yet, our sample size is inadequate to report this complication

There were no cases of non-union reported in our study comparable to Levent karapinar et al. [46] wherein there was no reported cases of non-union. Studies which reported non-union were highlighting that higher types (type 3 and 4) showed tendency towards non-union.

Peroperative and postoperative Femoral fractures have been documented in patients treated with the PFN and PFN A-II. Multiple factors have been implicated like implant design and. operative technique. Decreases in implant curvature, diameter, over reaming of femoral canal by 1.5 to 2mm, insertion of the implant by hand and meticulous placement of the distal locking. Screws without creating additional stress risers decreases the complication rate of femoral shaft fracture (I.B. Schipper et al 2004)[48]. Patients with narrow femoral .canal and abnormal curvature of the proximal femur are relative contra-indications to intramedullary implants (Halder et al 1992)[29]. We have followed these recommendations in our series. Hence in our series we don’t have encountered any preoperative and postoperative femoral. shaft fractures. A larger cohort of patients is necessary to document the incidence of preoperative and postoperative femoral shaft fractures, which is a limitation of our study.

In short the PFN A-II is a better implant with specific design superior to conventional PFN and with distinct advantages over other implants to treat intertrochanteric fractures. With adequate surgical technique, the advantages of the PFN A-II increases and the complication rate decreases.

CONCLUSION

CONCLUSION

Intramedullary nailing with the PFN A-II has distinct advantages over Conventional PFN or DHS like shorter operating time and lesser blood loss for elderly, osteoporotic unstable trochanteric fractures.

Early mobilization and weight bearing is allowed in patients treated with PFN A-II thereby decreasing the incidence of bedsores, uraemia and hypostatic pneumonia. The operative time is much lower compared with other procedures which also contributes with lesser blood loss.

The incidence of postoperative femoral shaft fractures, Non-union rates in PFN A-II can be reduced by good preoperative planning and correct surgical technique, adequate reaming of the femoral canal, insertion of implant and meticulous placement of distal locking screws.

PFN A-II is a significant advancement in the treatment of trochanteric fractures which has the unique advantage of closed reduction, preservation of fracture hematoma, minimal soft tissue damage during surgery, early rehabilitation and early return to work.

CASE ILLUSTRATION

CASE ILLUSTRATION

CASE 1 & 2 (Bilateral case) 78 year old male, Bilateral trochanteric fracture

PRE-OP X RAY

Figure 34 : Right side intertrochanteric fracture (Case 1)

Figure 35 : Showing post-op, 3 months and 6 months follow up x-ray

Figure 36 : Left side intertrochanteric fracture (Case 2)

Figure 37 : Showing post-op, 3 months and 6 months follow up x-ray

Figure 38 - CLINICAL FOLLOW UP AT 6 MONTHS

CASE 2

Figure 39 : Pre op x ray showing intertrochanteric fracture on left side

Figure 40 : Intra-op c-arm images

Figure 41 – Showing post-op, 3 months and 6 months follow up

Figure 42 - CLINICAL FOLLOW UP AT 6 MONTHS

CASE 4

Figure 43 : Pre-op x ray

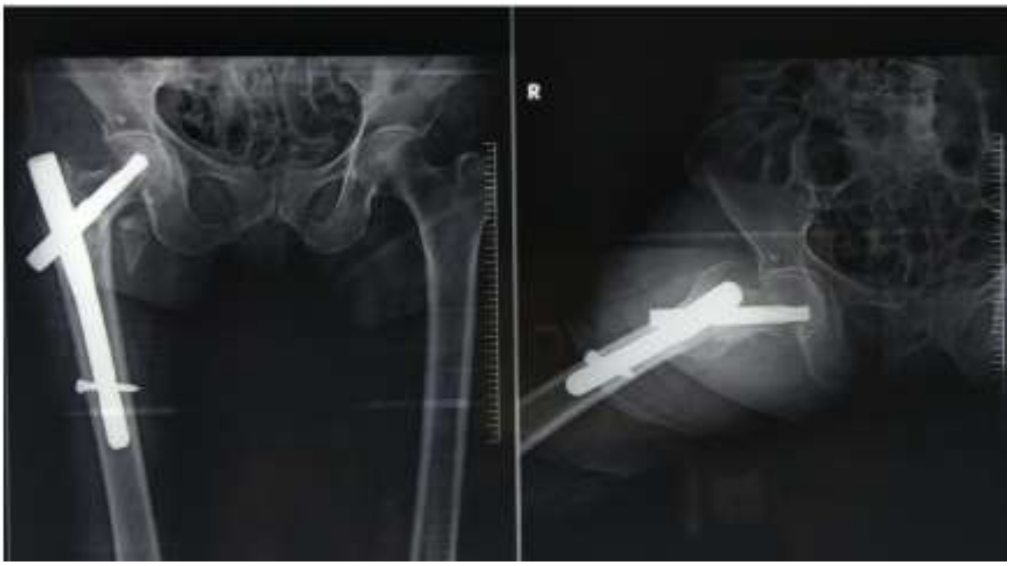


Figure 44 : Post-op x ray

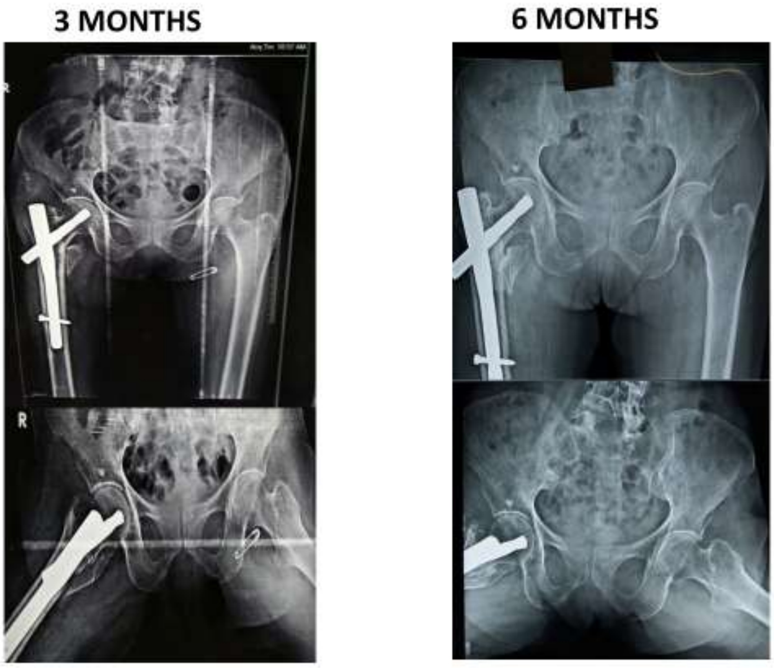


Figure 45 : 3 months and 6 months follow up

CLINICAL FOLLOW UP AT 6 MONTHS

CASE 5

Figure 46 : Pre-op x ray

3 MONTHS **6 MONTHS**

Figure 47 : 3 months and 6 months post-op

CLINICAL FOLLOW UP AT 6 MONTHS

CASE - 6

Figure 48 : Pre op, Post op, 3 months and 6 months x ray

CLINICAL FOLLOW UP AT 6 MONTHS

PROFORMA

NAME:

ADDRESS **:**

AGE **:** SEX **:**

IP No **:** Unit **:**

DOA **:**

DOS **:**

WARD **:**

Mode of Injury **:** Side of Injury **:** R/L

Associated Injuries : Head / Abdomen / Pelvis / other limb injuries

Boyd and Griffin Classification type **-**

Investigation

- Plain X**-** Ray Pelvis AP / Lateral views
- Urine Routine examination
- Blood Hb % / BT / CT / Urea / Sugar / Grouping and typing
- Chest X –Ray
- ECG

INITIAL MANAGEMENT :

Improvement of General Condition

Upper tibial pin traction / Bohler Braun splint

Details of other treatment particulars

SURGERY

- Interval between injury and surgery
- Patient positioning
- Operating time
- Entry Portal
- Method of fracture reduction
- Length and diameter of nail
- Length of helical blade
- Details proximal and distal locking
- Amount of blood loss
- Transfusion , if any
- Fluoroscopic exposure (shots used)

COMPLICATIONS AND POST-OP EVENTS

Bed sores

Superficial infection

Deep infection

Non-union

DVT

Helical blade cut out/ revision surgeries

Varus positioning

Peroperative / postoperative femoral shaft fracture

Failure of distal locking

Abductor lurch

Post-op hip pain

CLINICAL AND RADIOLOGICAL ASSESSMENT

Fracture union time in weeks –

HARRIS HIP SCORE at 3 months -   /100

HARRIS HIP SCORE at 6 months -   /100

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PATIENT CONSENT FORM

Study detail:

"Functional outcome of Intertrochanteric fractures treated by Proximal Femoral Nailing Anti-rotation-II"

Study centre : GOVT ROYAPETTAH HOSPITAL, CHENNAI

Patients Name :

Patients Age :

Identification Number :

Patient may check (✓) these boxes

I confirm that I have understood the purpose of procedure for the above study. I had the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, ☐

I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

I hereby make known that I have fully understood the use of above surgical procedure, the possible complications arising out of its use and the same was clearly explained to me and also understand that this technique is a new method of treatment of patella fractures and this study is done to know the usefulness of the same in management of patella fractures ☐

I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well-being or any unexpected or unusual symptoms. ☐

I hereby consent to participate in this study. ☐

I hereby give permission to undergo complete clinical examination and diagnostic tests including hematological, biochemical, radiological tests. ☐

Signature/thumb impression:

Patients Name and Address: Place: Date:

Signature of investigator :

Study investigator's Name : Place: Date:

TAMIL CONSENT FORM

நோயாளி ஒப்புதல் படிவம்

ஆராய்ச்சியின் விவரம் :

ஆராய்ச்சி மையம் :

நோயாளியின் பெயர் : நோயாளியின் வயது :

பதிவு எண் :

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✔) செய்யவும்

1. மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்துகொண்டேன். மேலும் எனது அனைத்து சந்தேகங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன். ☐

2. மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிறேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்னறிவிப்புமின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும், இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன். ☐

3. ஆராய்ச்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரோ, ஆராய்ச்சி பேராசிரியரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிற ஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக்கொள்ளலாம் என்றும், மேலும் இந்த நிபந்தனை நான் இவ்வாராய்ச்சியிலிருந்து விலகினாலும் தகும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவுகளும் (சட்டபூர்வமான தேவைகள் தவிர) வெளியிடப்படமாட்டாது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சியிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெறிவிக்கமாட்டேன் என்று உறுதியளிக்கின்றேன். ☐

4. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சிக் குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் இந்த ஆராய்ச்சி காலம் முழுவதும் எனது உடல் நிலையில் ஏதேனும் மாற்றமோ அல்லது எதிர்பாராத பாதகமான விளைவோ எற்படுமாயின் உடனடியாக ஆராய்ச்சி குழுவினரை அணுகுவேன் என்றும் உறுதியளிக்கின்றேன். ☐

5. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவப் பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கின்றேன். ☐

6. இந்த ஆராய்ச்சிக்கு யாருடைய வற்புருத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயஅறிவுடனும் முழுமனதுடனும் சம்மத்திக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன். ☐

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை ஆராய்ச்சியாளரின் கையொப்பம்

இடம்: தேதி:

MASTER CHART

MASTER CHART

S.No.	Name	Age	Sex	IP. No.	Mode of injury	Classification	Side	Associated Injury	Interval Between injury and surgery	Reduction Open/closed	Nail size	Operating (time mins)	Blood Loss (ML)	Flouroscopic Shots	Complications	Time for union weeks	Harris hip Score		Followup in months
																	3 months	6 months	
PROXIMAL FEMORAL NAIL A-II																			
1.	Mr.Ranganathan	78	M	103763	RTA	III	R		9 Days	Closed	9X170	43	130	13	Nil	15	80	85	15
2.	Mr.Ranganathan	78	M	117432	RTA	II	L		4 Days	Closed	10X170	75	150	15	Nil	12	80	85	10
3.	Mr.Gopal	62	M	124597	RTA	IV	L		8 Days	Closed	9X170	72	50	13	Nil	13	70	70	12
4.	Mrs.Christian xavier	58	F	129543	RTA	I	R		5 Days	Open	9X170	78	275	12	bed sore	13	90	91	11
5.	Mrs.Laksmi	63	F	130721	Self fall	III	R	Distal radius fracture	5 Days	Closed	11X170	47	150	15	Nil	12	72	74	11
6.	Mr.Sathyamoorthy	55	M	133799	RTA	III	L		2 Days	Closed	9X170	55	145	12	Nil	16	80	84	10
7.	Mr.Balammal	82	F	133799	RTA	IV	R		6 Days	Closed	9x170	90	80	15	Bed sore deep infection	16	73	75	10
8.	Mr.Rajalakshmi	70	M	154007	Self Fall	III	L		7 Days	Closed	12X170	65	100	14	Nil	12	73	75	9
9.	Mr.Muthulakshmi	78	M	155002	RTA	III	L		8 Days	Closed	10X170	70	100	13	Nil	12	90	90	8

10	Mr.Sridharan	70	M	162131	RTA	IV	R		3 Days	Closed	11X170	97	100	13	Superficial infection	13	86	92	7
11	Mrs.Andal	74	M	163320	RTA	III	R		6 Days	Closed	10X170	70	140	12	Nil	13	80	84	7
12	Mrs.Shanthi	48	F	165120	Self fall	II	L		2 Days	Closed	9X170	58	85	15	Nil	13	80	83	7
13	Mrs.Karpagam	70	F	155784	Self fall	IV	R		4 days	Closed	10X170	70	130	13	Nil	13	80	82	10
14	Mrs.Lakshmi	60	F	112453	Self fall	IV	L		5 days	Closed	10X170	78	150	14	Bed sore	13	80	82	9
15	Mrs.Radha	64	F	112437	Self fall	II	R		6 days	Closed	11X170	48	150	15	Deep infection	12	80	80	9
16	Mr.Kuppan	80	M	176580	RTA	II	R		5 days	Closed	9X170	55	140	18	Superficial infection	15	80	82	9
17	Mr.Saravanan	83	M	146675	Self fall	II	L		4 days	Closed	11X170	50	150	8	Deep infection	13	80	82	8
18	Mr.Udhayakumar	61	M	113098	Self fall	II	L		5 days	Closed	11X170	49	150	20	Superficial infection	12	80	82	7
19	Mr.Rajan	77	M	117564	Self fall	II	L		5 days	Closed	11X170	50	140	9	Nil	13	80	85	8
20	Mr.Ibrahim	72	M	110203	Self fall	II	R		6 days	Closed	11X170	55	100	8	Nil	12	82	83	7
21	Mr.Gandhiselvan	74	M	114460	Self fall	II	R		7 days	Closed	11X170	39	100	17	Nil	12	80	80	8
		69.4							**5.4Days**			**62.6**	**130**	**13.5**		**13.09**	**79.8**	**82.3**	**9.4**